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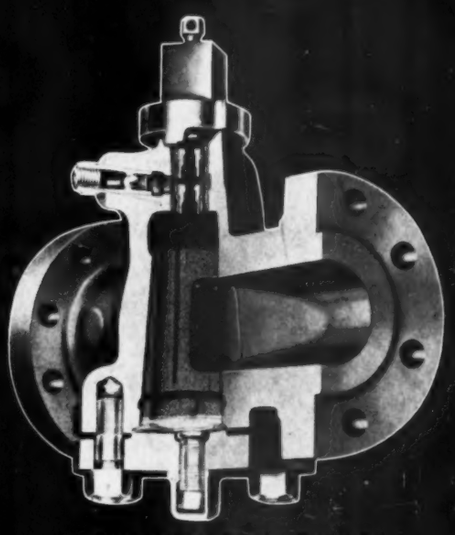

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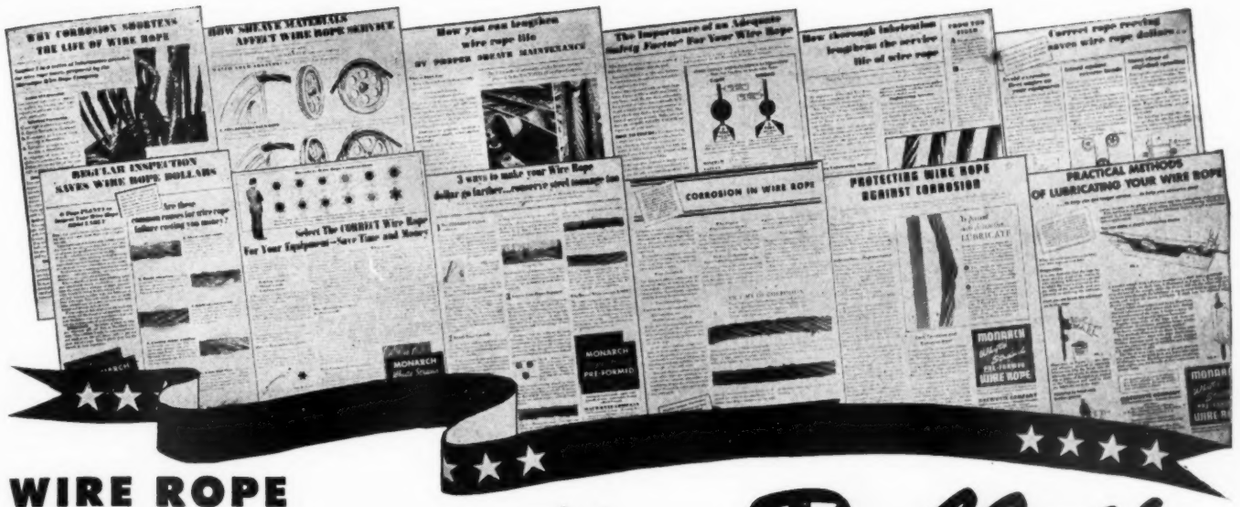
WHY CORROSION SHORTENS THE LIFE OF WIRE ROPE
HOW SHEAVE MATERIALS AFFECT WIRE ROPE SERVICE
How you can lengthen wire rope life BY PROPER SHEAVE MAINTENANCE
The Importance of an Adequate Safety Factor For Your Wire Rope
How thorough lubrication lengthens the service life of wire rope
Correct rope reeving saves wire rope dollars
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WIRE ROPE *Conservation Bulletins*

SENT ON REQUEST

We pause in this series of informative articles for wire rope users to review briefly the 12 thus far published . . . and provide an opportunity for those who may not have seen them to obtain reprints.

The purpose of this series of single-page illustrated articles on wire rope conservation is to help you conserve your wire ropes. This helps you, and helps our country for it means conservation of steel. We shall be glad to send you any or all of the articles listed below which readers tell us are useful and helpful.

1 ***Why Corrosion Shortens the Life of Wire Rope.*** Tells cause, effect, and suggests remedy for corrosion. Also explains how proper lubrication helps wire rope stand up against elements.

2 ***How Sheave Materials Affect Wire Rope Service.*** Pictures effect of hard and soft sheaves on wire rope. Explains what to watch for, how to avoid rope and sheave damage.

3 ***How You Can Lengthen Wire Rope Life by Proper Sheave Maintenance.*** Includes handy reference table on groove tolerances. Also points out 3 ways to save wire rope dollars.

4 ***The Importance of an Adequate Safety Factor.*** What is it? How Found? When is wire rope overloaded? What are minimum safety factors for various loads? All are answered in this easy-to-read, informative article.

5 ***How Thorough Lubrication Lengthens Service Life of Wire Rope.*** Explains two lubricating methods. Shows effect (Pictures) of ropes left unprotected.

6 ***Correct Rope Reeving Saves Wire Rope Dollars.*** Discusses fleet angles, reverse bends, rope spooling and what to do about them.

7 ***Regular Inspection Saves Wire Rope Dollars.*** Lists 6 common causes of wire rope failure. All can be avoided if rope user follows simple inspection procedure suggested.

8 ***Select the Correct Wire Rope for Your Equipment—Save Time and Money.*** Explains how Flexibility, Abrasion Resistance, and Strength are determined to meet varying conditions of Bending Fatigue, Abrasive Wear, and Loading Stress.

9 ***3 Ways to Make Your Wire Rope Dollar Go Farther—Conserve Steel Tonnage Too.*** Especially valuable to men actually handling wire rope.

10 ***Corrosion in Wire Rope.*** Gives further information on how to combat this rope destroyer. Supplements informative article number 1.

11 ***Protecting Wire Rope Against Corrosion.*** Shows some results of forgetting to inspect and protect wire rope with proper lubrication.

12 ***Practical Methods of Lubricating Your Wire Rope.*** Illustrates simple ways to lubricate your wire rope on the job. Very practical, useful for everyone concerned with wire rope care.

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VOL. XIV No. 3

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MEMBER A. B. C.—A. B. P.

(The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N

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The Course of Oil

WAR AND WILDCATTING

An editorial on a crucial national oil problem, from the November issue of the *Red Triangle Magazine*, a publication of Continental Oil Company.

A TREMENDOUS war effort has been under way for almost a year. When we view its proportions involving boundless material procurement, with the attendant administrative organization, little blame can be placed on anyone for the confusion that has existed since December 7, 1941. The assembling of man power and materials for a world conflict must have superman proclivities. Our greatest deterrent has been the necessity for setting aside political ambitions and party prejudices that have no place in the business of all-out war. The small business man has more than anyone else been in the throes of trying to save himself, but much needed mass production of everything in unbelievable quantities has largely thrown the burden of war preparation and supplies on those units with facilities for quick conversion.

For the past ten or twelve years, the petroleum industry has been in position to produce a raw product and its finished fractions much beyond consumptive demand. Those days are gone for, at least, the duration of the war. Since the beginning of war preparedness we have been living on our fat. Now in various ways the pinch of industrial regulations and ceilings is being felt, and we seem to be on high center in a state of inertia.

The start of the conflict necessitated highly expanded mechanization requiring petroleum products, which for some time undoubtedly will test our ability to produce and manufacture. A maximum withdrawal from underground reserves seems imminent. Somebody's face is going to be red when the peak of war demand for fuel and lubricants is reached and nature tells us she is doing her utmost from known reservoirs.

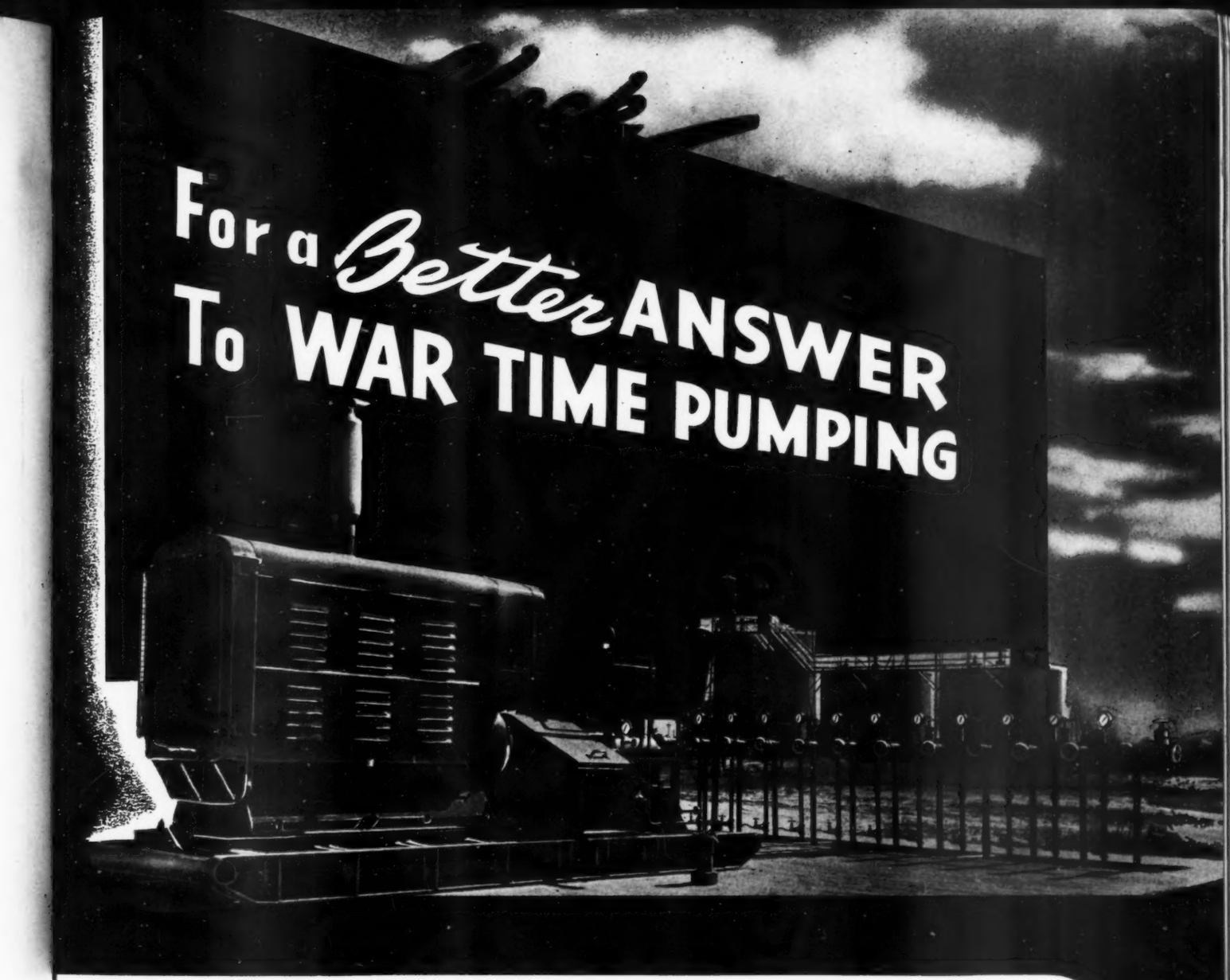
The oft-quoted figure on oil reserves with which various bulletins, reports, house organs, and industrial publications have tampered is approximately 20,000,000,000 barrels. This figure has been used so frequently without contest that the material behind it has been accepted as that which is available for our war machine. There are a number of us who have lived through many oil booms, have watched the demise of high expectancy, and accepted as a natural trend the quick depletion of initially prolific production hurriedly brought to the surface. This writer has had intimate knowledge of most fields in the Western hemisphere and has seen forty years of activities that carried with them over-optimism, wishful thinking, and the fallacy of guesses made when the pay is first penetrated. This is the time to think straight, to eliminate arbitraries, and deal with only those things that are factual, determining where we stand primarily on the proposition of oil available to us for the next two or three years so that we will not find our soldiers stymied on any front. Controversies having to do with oil have hinged upon what might be called "lobbying" for sustaining in the revenue act the provision dealing with depletion and appearing before governmental groups for relief from the Price Administrator's ceiling on crude oil. Sufficient proof from every possible source has been offered to justify these appeals, but those in the saddle, who rule on matters of this kind, have been adamant on the position they have taken, offering irrelevant argument in opposition. It is this writer's opinion that by its opposition the government is throttling an effort more vital to the successful conclusion of the war than could be done by any other means.

The decline in discoveries over the past five years, the lack of development in proven and semi-proven areas, and the cessation in wildcatting for new reserves in twenty oil producing states indicate very definitely that the annual production from 1943 to 1947, inclusive, will be as follows:

1943	1,349,650,000	barrels
1944	1,283,100,000	"
1945	1,189,525,000	"
1946	1,086,555,000	"
1947	995,610,000	"

This represents a decline in production, between the years of 1942 and 1947, of 372,410,000 barrels, estimating the production for 1942 at 1,368,020,000 barrels.

To give some idea of a safe rate of extraction with the time element as a factor and assuming we do have 20,000,000,000 barrels underground, another approach to our situation gives us a definite warning. By studying the history of oil production and the economics of various methods of recovery, we find that it will take forty years for us to recover 16,360,000,000 of the estimated 20,000,000,000 barrels. Furthermore, we think it is only possible for us to lift, free of severe water contamination, a total of 5,904,000,000 barrels for the period 1943 to 1947, inclusive, which is 36.1 percent of our stated total reserves. While we are a little late, it is believed that the administration must promptly become cognizant of the fact that reserves are not made available for any purpose by the mere manipulation of a valve. Every well and every field, no matter where located, presents a problem to secure maximum recovery which must necessarily be governed by a time factor. A large line drawing upon mid-western reserves at the rate of 300,000 barrels a day calls for an annual supply of 109,500,000 barrels. In addition, strategically located places and plants are being selected for toluene, high octane gasoline, and rubber manufacture, all of which demand the heart of any crude being processed and, in many instances, selected crudes. To stop exploration and exploitation at a time when oil is so vital to our cause is instituting a short sighted policy that can lead us into an unnecessarily prolonged combat. This writer expresses the opinion that we must let down the bars on wildcatting and, in doing it, give the wildcatter a price justifying the speculative undertaking which at best is a 5-to-1 shot—regardless of scientific methods of location that only offer to find favorable structural conditions on which oil might be found.



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Highlights IN OILDOM

Ickes Made Petroleum Administrator

By executive order of President Roosevelt the Office of Petroleum Administrator for War has been established with Harold L. Ickes as Petroleum Administrator.

The new agency supplants the former Office of Petroleum Coördinator for War, which Ickes had headed since its establishment May 28, 1941, under a letter from the President immediately following declaration of an emergency.

The new order confers a broad delegation of war authority upon the administrator. The President's pre-war instruction to the coördinator was that he "make specific recommendations to appropriate departments." The new executive order provides that "the administrator shall establish basic policies and formulate plans and programs to assure for the prosecution of the war the conservation and most effective development and utilization of petroleum in the United States and in territories and possessions and issue necessary policy and operating directives."

Section 3 (d) of the order centralizes in the administrator control over the petroleum industry by delegating far-reaching authority under the President's war powers. This includes the power to issue and enforce necessary orders and directives regulating all the operations of the vast petroleum industry. It also empowers the administrator to distribute among the branches and between companies engaged in the oil industry, whatever quantities of critical materials are allotted for the use of the industry by the War Production Board.

In the foreign field, the administrator "shall collaborate with the appropriate federal departments and agencies authorized to determine plans and policies with respect to foreign petroleum activities and in conformity with such plans and policies . . . issue directives concerning the physical operations of their foreign petroleum facilities to units of the American petroleum industry which directly or indirectly engage in such operations in foreign countries."

Concerning petroleum supplies for civilian consumption, the order states that the administrator shall "be advised of all plans or proposals which deal with the civilian rationing of petroleum and consult with rationing authorities in the development of such plans or proposals, and in those instances where rationing is for the purpose of maintaining adequate supplies of petroleum for war and essential industrial and civilian requirements determined after advising with the War Production Board the areas and the time within which such rationing should be effective and the amount of petroleum available for such purposes."

That section of the order dealing with rubber, read in connection with the operating agreement between the Rubber Director and the Petroleum Administrator, means that the Petroleum Administration will conduct and promote developmental research in the production of petroleum components for rubber, develop plans for new production of such materials, and be responsible for new refinery installations and their subsequent operation.

The order requires that all other departments of government "shall advise with the administrator before taking any action which might affect the continuous ready availability of petroleum for military and essential industrial and civilian needs."

The Petroleum Administration for War exists under the order as an independent war agency, the administrator reporting directly to the President. There is provided a deputy administrator, to whom the administrator may delegate "any and all power, authority and discretion conferred upon him," and who "shall serve as acting administrator in the absence of the administrator." Ralph K. Davies, who has been Deputy Coördinator since the establishment of that office, becomes in the new organization the Deputy Petroleum Administrator.

Administrator Ickes said:

"In assuming the duties of Petroleum Administrator, I desire to accent two major facts: First, that the supplying of oil to our armed forces and those of our allies is no less than a prerequisite to survival; and, second, that the successful carrying out of this task is one of enormous proportions—one which will call for tireless efforts, unending study, and continuing sacrifice, affecting directly or indirectly in some way every man, woman, and child."

Hearings on Water-Oil Ratio Order Postponed

Hearings on two suits attacking the Railroad Commission's water-oil ratio order for the East Texas field have been postponed until tests on wells involved are completed. Postponements were by agreement between attorneys for the East Texas operators and those of the Railroad Commission.

Judge Roy C. Archer of the Ninety-Eighth District Court had set for hearing on December 4 the suit of Konowa Operating Company and more than 20 other operators, involving 129 wells. The second suit, filed by Roosth and Genecov Production Company of Tyler originally was set for hearing in the 126th District Court. It involved 27 leases with about 50 wells.

The postponements were ordered after Chairman Ernest O. Thompson of the Railroad Commission had announced that enforcement of the order would not be attempted until commission engineers completed tests on the wells involved in the first suit, and estimated the tests would require 25 days or more.

The water-oil ratio order was instituted as a move to check the downward trend of bottom-hole pressure in the East Texas field. The order specified that no well in the field may be operated to produce more than 10 bbl. of water for each barrel of oil.

The order originally was intended to go into effect December 1.

Chairman Thompson and Commissioner Beauford H. Jester signed the order. Commissioner Olin Culberson dissented.

The two suits brought by operators against the Railroad Commission allege that the order limiting the ratio of water that may be withdrawn with oil violates the marginal well law.

California Dim-Out Regulation Extended

A 30-day extension of the California oil industry's temporary variance from dim-out regulations has been granted by the Office of Civilian Defense. Originally scheduled to expire at midnight, November 25, the variance has been extended to midnight December 25.

The original variance was granted the oil industry for producing and drilling operations in order to assure uninterrupted production, thus maintaining adequate supplies of oil for military and civilian use. Later, other variances were granted pipe line and natural gasoline operations.

Terms of the variance were worked out by the Oil Industry Protection Committee in collaboration with Frank A. Hansen, lighting consultant for the Office of Civilian Defense. At the present time, a comprehensive plan for oil-industry lighting is being formulated, with the expectation that when it is completed, it will serve as the basis for a permanent variation from the current dim-out regulations for all necessary operations.

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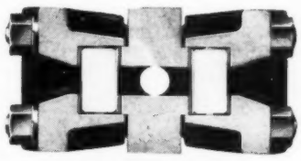

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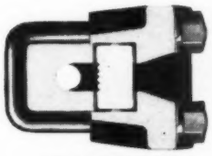

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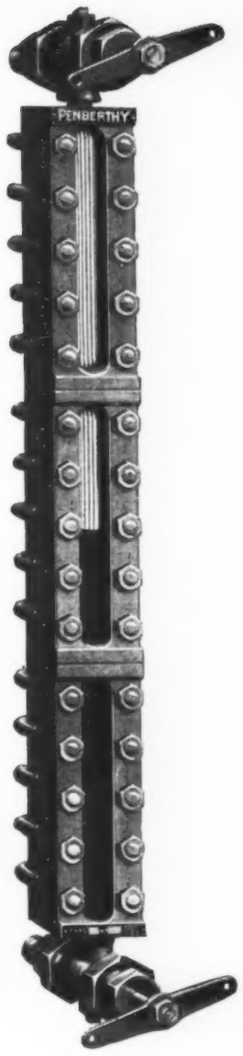

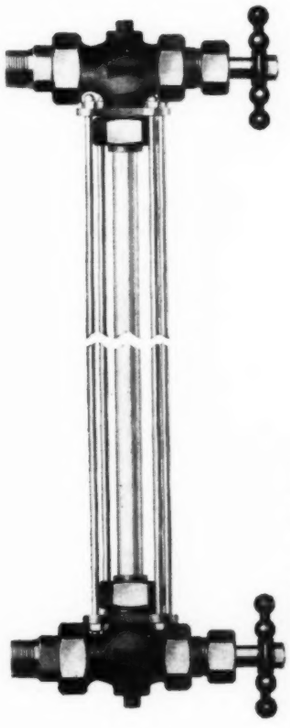

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MAJOR *Refining* ACTIVITIES

ANOTHER of the large-scale government-financed synthetic rubber plants has just begun operating, according to a report by John L. Collyer, president of the B. F. Goodrich Company of Akron, Ohio.

The new plant, situated in Kentucky, is an important unit in the government's synthetic rubber program, which on completion calls for the production of more than 875,000 tons of synthetic rubber annually.

This newest synthetic rubber plant will ultimately utilize butadiene made from alcohol and will shortly be in full-scale production of general purpose synthetic rubber for use by the armed forces of the United Nations.

The B. F. Goodrich Company, after a 16-year research program in synthetic rubber, constructed the first complete privately owned commercial synthetic rubber plant in this country in 1939. First automobile tires made with Ameripol, the company's own synthetic rubber, were introduced for sale in 1940 and are now in service on several thousand passenger cars and light trucks throughout the nation.

The refinery owned by the Douglas Oil and Refining Company, a 10,000-bbl. unit, between Los Angeles and Wilmington, California, has been sold to the U. S. S. R. on a lend-lease arrangement. The transaction was confirmed in Washington, D. C. The U. S. Treasury Department has purchased the plant and will arrange to dismantle and ship the plant to Russia.

Cracking unit of the 10,000-bbl. plant is designed to process approximately 9000 bbl. per day of 17-gravity reduced crude, yielding about 3300 bbl. of 400 end-point 10-lb. gasoline. The distillation unit of the plant was designed to process 9,000 to 10,000 bbl. per day of 25-gravity mixed base crude oil. Optional installation of additional facilities at practically all stages of processing were provided for in the design of the plant. It is this flexibility feature that makes the plant especially well suited for shipment to Russia to produce fuels for that country's war machinery. Sale of this equipment to Russia is reported to be only one phase of a refinery aid program to that country for aviation fuels that will have a total value of from $15,000,000 to $20,000,000.

The commitment of the Defense Plant Corporation to the Crown Central Petroleum Corporation of Baltimore, Maryland, with which to install additional facilities at the firm's Texas Gulf Coast refinery has been increased $900,000 to total more than $7,000,000. The oil company, one of three petroleum refiners commissioned to supply raw material for the synthetic rubber plant now under construction by Sinclair Rubber, Inc., will operate the facilities for the Defense Plant Corporation, who will retain ownership of the equipment.

The St. Clair Processing Corporation, Ltd., which recently was incorporated as a subsidiary of Imperial Oil, Ltd., is the third Canadian concern formed for the purpose of operating units of synthetic plants being built by Polymer Corporation, Ltd., as part of the Dominion Government's rubber program.

Butadiene and butyl rubber plants at Sarnia will be operated by the new corporation for the Polymer Corporation.

Dow Chemical Company of Midland, Michigan, will operate the styrene plant and the polymerization plant will be operated by Canadian Synthetic Rubber, Ltd., which is owned jointly by Dominion Rubber Company, Ltd., the Goodyear Tire and Rubber Company of Canada, Ltd., and the B. F. Goodrich Rubber Company of Canada, Ltd.

Sonken-Galamba Supply Company of Tulsa, Oklahoma, has purchased the Dubbs refinery of the Titan Oil Company of Stark, Michigan, according to W. C. Berry, president of Sonken-Galamba. The plant included a 4000-bbl. topping plant, a 2000-bbl. vis-breaker unit, and a 500-bbl. asphalt unit. Features of the plant include a complete instrument panel, electric-eye control, pump house complete with explosion-proof motor-driven centrifugal pumps, and 18 heat exchangers.

Completion of a $1,000,000 purification and processing plant, which has been under construction for the past year, has enabled the Imperial Oil, Ltd., refinery at Sarnia, Ontario, to begin delivery of refinery-still gas to the Union Gas Company of Canada.

E. B. Badger and Sons Company, Boston, Massachusetts, has been awarded the contract to construct a butadiene plant for the Sun Oil Company at the firm's Toledo, Ohio, refinery. The plant will be built in conjunction with the Defense Plant Corporation. The new plant employs the catalytic dehydrogenation of butane process with a capacity of about 15,000 tons per year.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended November 28, 1942
A.P.I. Figures

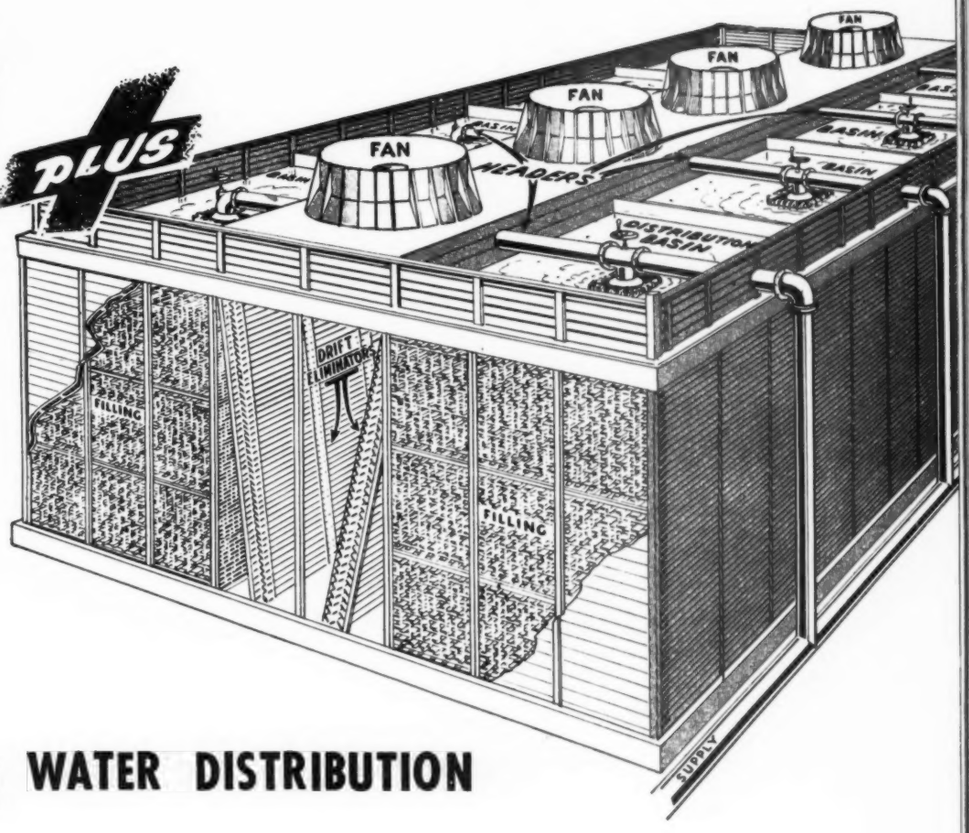
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	88.2	1,639	67.2	37,785	44,495
Appalachian	84.8	162	92.0	2,549	1,148
Ind., Ill., Ky.	84.9	747	92.9	13,467	8,779
Okla., Kans., Mo.	80.1	372	89.4	5,996	3,481
Rocky Mountain	48.0	89	60.5	1,481	1,023
California	89.9	727	89.0	17,576	68,609
TOTAL U. S.— B. OF M. BASIS NOV. 28, 1942	85.9	3,736	77.8	(a)78,854	127,535
TOTAL U. S.— B. OF M. BASIS NOV. 21, 1942	85.9	3,722	77.5	78,583	126,553
U. S. B. OF M. BASIS NOV. 29, 1941	.....	4,145	.....	86,889	150,068

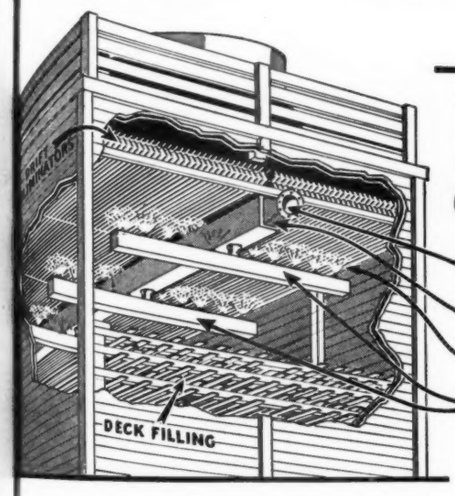
(a) Finished, 69,842,000 bbl; unfinished, 9,012,000 bbl.
*At the request of the Office of Petroleum Co-ordinator.

Another of MARLEY'S Features

PLUS



Complete and Uniform WATER DISTRIBUTION



—In MARLEY "STANDARD" Induced Draft Cooling Towers

Flanged Inlet CONNECTION

Open Flume HEADER

UP-SPRAY NOZZLES

DISTRIBUTION LATERALS Spaced for Uniform Coverage

Fullest efficiency in a cooling tower calls for *uniform* distribution of water over the entire fill area — no "dead spots". In Marley "Standard" towers this is accomplished by a unique system that achieves the results of high-pressure spray distribution *without* its extra pumping cost. Only sufficient pressure is required to raise water into the Header Flume from whence gravity pressure fills the Distribution Laterals completely and forces the water out through *up-spraying* nozzles. Thus, discharge from all nozzles is everywhere perfectly equalized, water is exposed to the passing air throughout a longer fall, and still finer break-up is provided as it splashes, evenly spread, over the top deck of the tower filling.

—In MARLEY "DOUBLE-FLOW" Induced Draft Cooling Towers

Water distribution in the Marley "Double-Flow" presents advantages as usual as the patented design of the tower itself. It is the only cooling tower having the primary distribution system *entirely external*, with all parts open to view and easy to reach while in operation.

Also *full, even* distribution is maintained from as little as 10% of normal capacity up to 200%, with no change in the distribution system or in the tower's efficiency.

The all-over uniformity of pressure distribution is combined with the economy of gravity-feed by utilizing the tower's roof to provide broad, shallow distribution basins, one on each side of each fan. Only slight pressure is needed to equalize water volume in all basins and from there distribution is by gravity alone. This is a major reason why the "Double-Flow" tower's pumping requirements are so extremely low—only 20 feet in most cases, or just enough to lift water to the top of the low tower.

From the supply risers, water is conveyed either by pipes or flumes to the basins, each equipped with an individual control valve for regulating volume. The water spreads out to a depth of several inches in each basin and falls with equalized force through a regular pattern of orifices in the basin floor. The top deck of filling inside the tower is specially designed to obtain an even spread and a thorough break-up of the water.

Effective water distribution at minimum pumping cost is just one more of the outstanding features which, added together, explain why among all cooling towers Marley is the name most frequently seen.

MARLEY COOLING TOWERS

8-42-A

This is one of a series of advertisements, each devoted to a Marley cooling tower feature which has become an accepted standard of best practice.

Every MARLEY TOWER *is individually engineered by* THE MARLEY CO., INC. — KANSAS CITY, KANSAS

MAJOR *Oil Field* ACTIVITIES

DELTA DRILLING COMPANY has opened a new field three miles northwest of Quitman in Wood County, Texas, in the Paluxy sand. The well is J. B. Goldsmith No. 1, Purse survey. On a 6-hr. Railroad Commission test the well flowed 181.5 bbl. of 43-gravity oil through ¼-in. choke on the 2-in. tubing. The tubing pressure was 590 lb. and pressure on the casing was 660 lb. Gas-oil ratio was 316 to 1. Shake-out showed 2 percent basic sediment. Production from the Paluxy was from perforations at 6280 to 6310 ft. At last reports the well had been shut in waiting on additional storage.

A wildcat test by Cities Service Oil Company, Jim Cook No. 1 in NWC 32-65n-39w, about 4 miles southeast of Tarkio in Atchison County, Missouri, topped the Bartlesville sand at 1408 ft. where stains were found in cuttings. Drilled to 1442 ft. the test found some free oil at about 1440 ft. Pipe is being run to test the Bartlesville sand.

Lizzie Pickler No. 1, section 23-17-21, about 1 mile south of Magnolia City, Arkansas, an exploration of Roy Lee of Dallas, Texas, associate of H. L. Hunt, for Smackover lime production, was preparing to set casing for a test of a lime section that is expected to produce oil although some observers see condensate as more likely.

The Smackover was topped at 8004 ft., porosity found at 8032 ft., water at 8078 ft., and the hole was bottomed at 8088 ft. Reports stated that the section below 9032 ft. carried staining throughout.

The Mid-Continent Petroleum Corporation and Dudley D. Morgan are reported to have promising indications of a producer in their Bonebrake No. 1, NW NE 32-17-5, Lincoln County, Oklahoma. Total depth of the well is 4093 ft. in the First Wilcox sand. Electrolog test showed oil and gas. The well made a gallon of oil and hour from the First Wilcox with no show of water. Plugged-back to 3420 ft., the casing was perforated with 72 shots opposite the Skinner sand between 3432 and 3449 ft. to make an estimated 8,000,000 to 12,000,000 cu. ft. of gas the first 24 hours and then flowed 23,000,000 cu. ft. with a spray of oil.

Bossier Parish, Louisiana, has a new pool or an extension of the Carterville pool one and one-half miles to the northwest. H. L. Hunt's well, Nebo No. 1, C SW SE, 3-23n-12w, is flowing an estimated 300 bbl. per day of 37.9-gravity crude oil through perforations in the casing opposite the Pettit lime and Travis Peak at a depth of about 6200 ft. Drilled to 6577 ft., casing was landed at 6252 ft. Swabbed down to 4000 ft., the well refused to flow. After acidizing with 5000 gal. the well began flowing through a 2-in. opening on 2½-in. tubing. The operator is installing separator and tanks.

The First National Petroleum Company has discovered sand production on the south edge of the Grayville pool of White County, Illinois, where previous production has been from the Biehl sand. The well, Fritz No. 2, in SE NE SW, 20-3s-14w, was shot with 145 quarts between 2808 and 2823 ft. and swabbed 225 bbl. of oil in 24 hours.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	$ .88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.93-1.36
Coalinga	.73-1.13	North Louisiana	.98-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	1.05-1.07		
New Mexico	.70-1.15	Indiana	.85-1.25
Texas		Ohio	
North Central	.97-1.21		
Panhandle	.70-1.12	Lima	1.50-1.60
West Texas	.80-1.27	Michigan	1.24-1.44
Gulf Coast	.93-1.48		
Darst Creek	1.14	Pennsylvania	
East Texas	.80-1.27	Bradford	3.00
Talco	.79	Southwest	2.65
Kansas	.93-1.25	Eureka	2.59
Oklahoma	.75-1.25	Buckeye	2.55
Arkansas	.94-1.36	Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.
(Figures in bbl. of 42 gal. each)

	[1]O.P.C. Recommendations November	Week Ended Nov. 28, 1942	Week Ended Oct. 31, 1942	Week Ended Nov. 29, 1941
Oklahoma	407,500	[2]365,700	368,050	425,100
Kansas	300,700	[2]299,100	297,700	249,200
Nebraska	3,400	[2] 2,950	3,450	5,800
Panhandle Texas		89,800	98,500	85,100
North Texas		137,600	140,000	138,000
West Texas		212,750	214,000	286,500
East Central Texas		95,800	90,200	86,100
East Texas		354,800	362,000	369,500
Southwest Texas		176,550	167,700	216,250
Coastal Texas		313,400	321,000	291,200
TOTAL TEXAS	1,381,000	1,380,700	1,393,400	1,472,650
North Louisiana		96,550	98,150	81,600
Coastal Louisiana		228,700	231,000	266,850
TOTAL LA.	333,800	325,250	329,150	348,450
Arkansas	77,200	73,600	73,350	74,050
Mississippi	50,000	[2] 60,950	69,200	74,450
Illinois	280,900	255,650	263,600	400,300
Indiana	18,400	[2] 16,200	15,900	18,400
Eastern (Not incl. Ill. and Ind.)	105,200	90,350	97,950	96,250
Michigan	64,500	58,400	60,200	56,950
Wyoming	94,400	90,700	89,750	82,050
Montana	24,800	22,550	21,850	21,400
Colorado	7,000	7,000	7,000	5,350
New Mexico	100,600	95,800	99,500	117,800
TOTAL EAST OF CALIF.	3,249,400	3,144,900	3,190,050	3,448,200
California	782,000	733,100	711,100	638,400
TOTAL U. S.	4,031,400	3,878,000	3,901,150	4,086,600

[1]O.P.C. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline and allied products in August, 1942, as follows: Oklahoma, 29,000; Kansas, 4,500; Texas, 102,400; Louisiana, 19,700; Arkansas, 2,800; Illinois, 8,800; Eastern (not including Illinois and Indiana), 8,400; Michigan, 200; Wyoming, 2,400; Montana, 200; New Mexico, 6,200; California, 42,100.

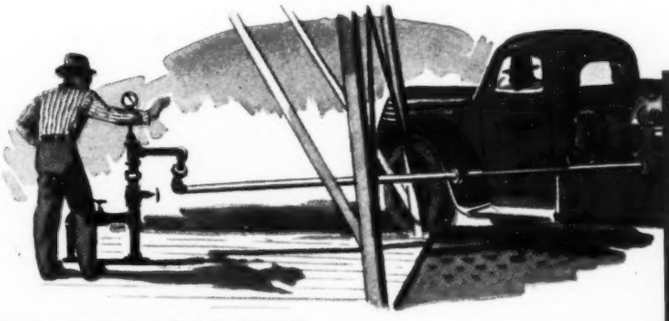
[2]Oklahoma, Kansas, Nebraska, Mississippi, Indiana figures are for week ended 7 a. m., November 25.

OIL IS AMMUNITION! To produce our needed requirements, the productive future of every well must be carefully guarded. ... Shortages of steel and manpower make this imperative.

The answer, then, is Dowell Reconditioning Service. It is designed to protect and lengthen the productive future of old wells. Thus, it aids in increasing the nation's oil reserves by postponing the time when old wells must be abandoned.

Dowell Reconditioning Service improves the productivity of any type of formation by increasing its permeability through the removal of paraffin deposits and scale accumulations, or by treating the formation itself.

Day by day, hour after hour, Dowell field men are completing *reconditioning* jobs and leaving behind them wells with new productive futures. Because this plan works for others, it will work for you. Let's talk it over—today.



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DOWELL
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CHEMICAL SERVICE

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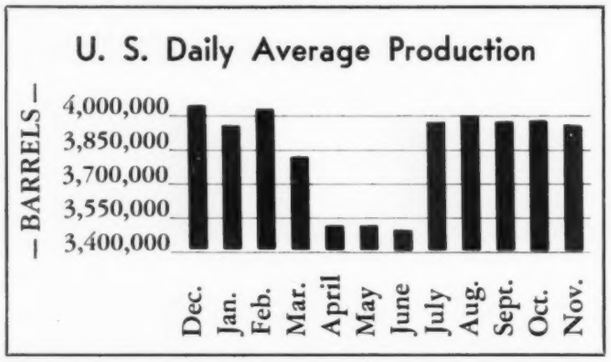
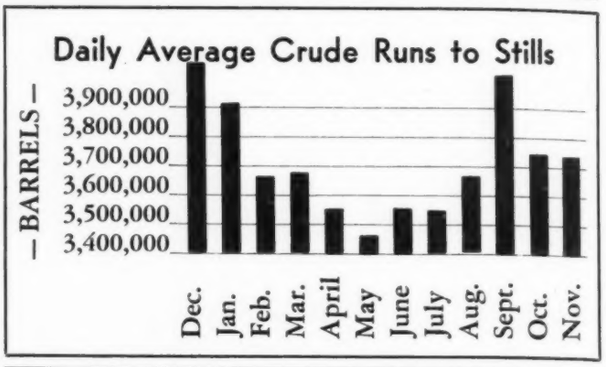
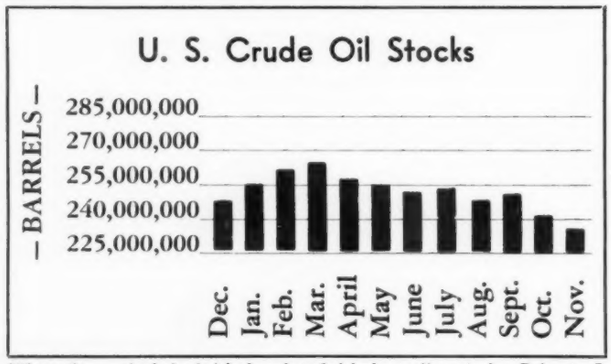
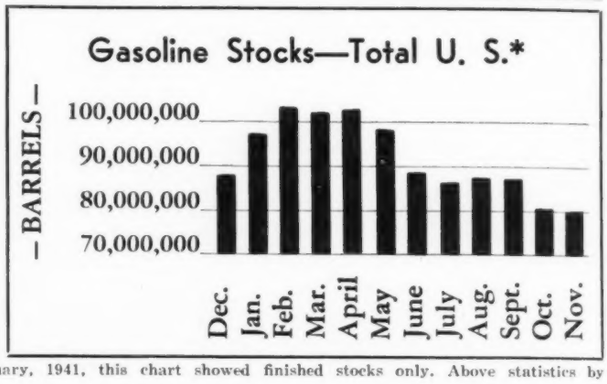
Subsidiary of The Dow Chemical Company

PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

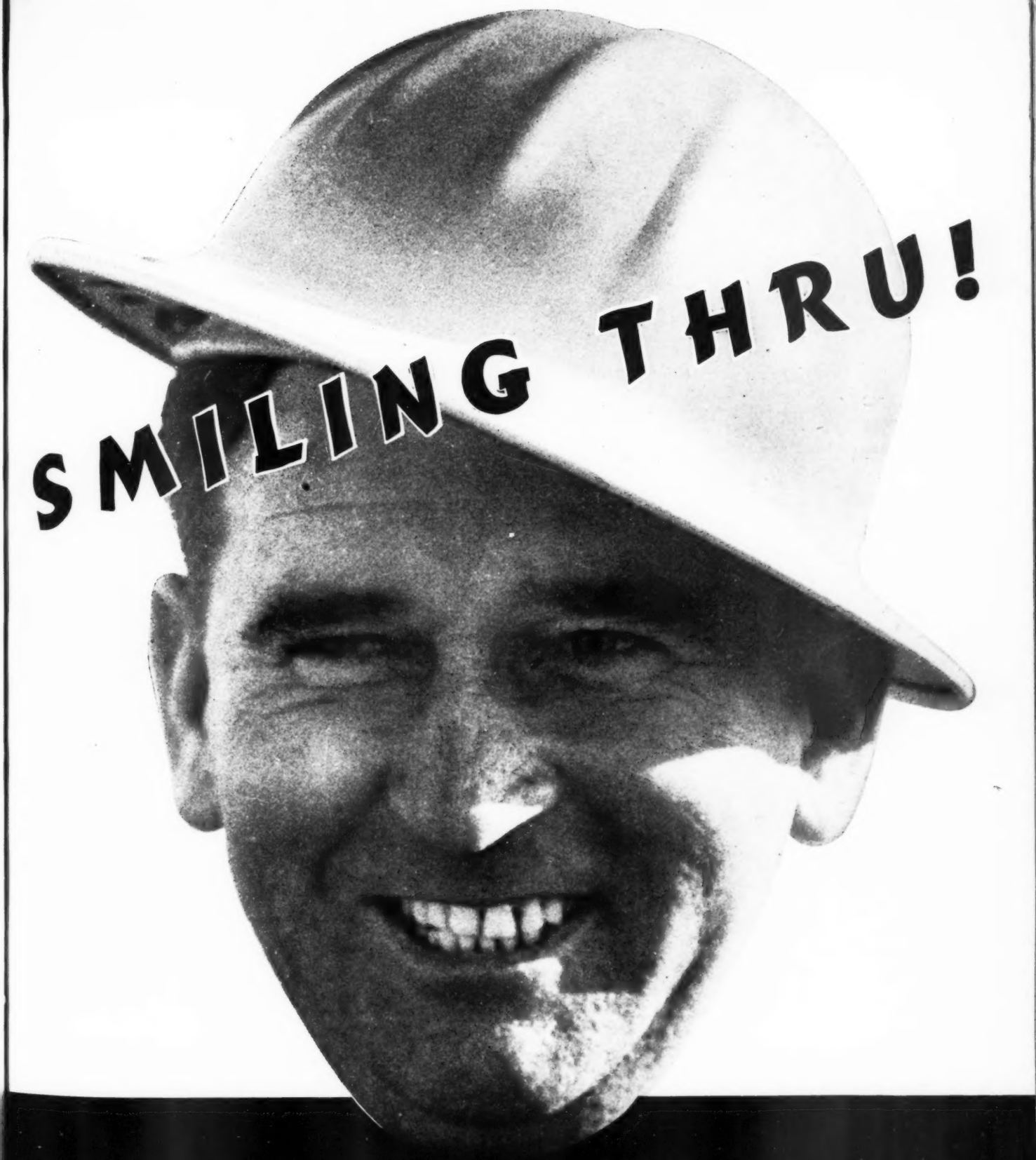
Summarized Operations in Active Fields for November, 1942

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	31	27	3	....	3500-3700	2	40	Rotary
Gaines County	4	2	5	....	4400-5584	2	22-35	Rotary
Hockley County	12	8	3	....	4800-6850	2	20-30	Rotary
Ector County	5	4	5	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	22	18	4	....	1700-3900	2	40	Rot.-Cab.
Nueces County	5	3	6	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	4	2	4	....	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	19	16	5	....	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	3	2	7	6	2150-4125	2 or 3	'38	Rotary
KANSAS								
Russell County	16	13	6	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	4	3	5	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	10	7	2	....	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	168	158	79	131	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	15	13	5	6	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	7	6	4	2	1840-11,450	3 or 4	14-30	Rotary
Wilmington County	5	4	3	1	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for November, 1942

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1941 (In Barrels)
	November	October	November	October	November	October	November	October	November	October	
Arkansas	16	18	11	14	9	13	3	6	10	18	29,263,000
California	38	50	31	44	23	22	62	33	106	33	230,271,000
Illinois	168	172	158	161	46	61	79	79	131	126	131,272,000
Indiana	25	31	19	23	15	17	4	6	14	14	6,998,000
Kansas	136	139	127	128	66	79	9	21	38	28	82,733,000
Kentucky	1	6	1	4	1	4	....	....	....	....	4,790,000
Louisiana	173	182	162	171	55	58	8	13	9	18	116,038,000
Michigan	24	26	18	20	10	9	6	10	7	7	16,312,000
Mississippi	3	5	1	3	....	....	....	....	....	....	15,528,000
Montana	5	13	3	9	....	....	....	....	....	....	7,440,000
Nebraska	3	4	2	1	4	3	....	....	....	....	1,785,000
New Mexico	39	46	37	43	30	36	....	....	....	....	39,109,000
New York	56*	69*	50*	65*	47	72	....	....	....	....	5,180,000
Ohio	36	41	30	35	21	34	....	....	....	....	3,342,000
Oklahoma	104	131	96	117	25	37	5	7	55	81	154,817,000
Pennsylvania	103*	118*	99*	109*	79	122	....	....	....	....	16,700,000
Texas	427	501	400	427	290	318	348	381	309	362	501,745,000
West Virginia	27	27	21	79	12	14	5	6	4	14	3,418,000
Wyoming	....	1	....	1	....	2	....	1	....	1	29,952,000
Total	1384	1943	1266	1454	733	901	529	563	683	702	1,398,485,000

*Includes water-intake and pressure wells.



Fighting and winning a global war is serious business. And whether you're battling to give shape to a new world order, fighting tooth and nail to keep a flood of vital oil flowing to our fighters, or struggling to keep the nose of your business above water because of material shortages and depletions . . . the fellow who can take it on the chin and smile stands a good chance to emerge victorious.

We of Republic are proud of our tie with the Industry which, since its very beginning, has always been able to take it, grin — and keep on going.

Republic Supply Company

GENERAL OFFICES: HOUSTON, TEXAS

MAJOR *Pipe Line* ACTIVITIES

PETROLEUM Administrator for War Harold L. Ickes has announced the selection of 12 contractors for the job of constructing the 857-mile eastward extension of the Texas-East Coast War Emergency Pipeline.

Letters of intent have been issued to a group of experienced construction companies whose personnel and equipment insure the speediest possible completion of the pipe line, Administrator Ickes said. Full-scale operations are planned right through the winter. Completion of the Illinois-East Coast extension from Norris City, Illinois, to the New York-Philadelphia refining areas is expected by mid-summer.

The line will be constructed of 24-in. pipe as far as Phoenixville Junction, Pennsylvania, with two 20-in. branches extending from that point to Bayway-Bayonne, New Jersey, and to Philadelphia.

Detailing construction plans for the second leg of the 300,000 bbl. per day oil carrier, Deputy Administrator Ralph K. Davies said that construction crews will "set in" promptly on 17 selected working spreads along the eastbound right-of-way. Already more than 100 miles of 24-in. pipe has been moved to storage sites along the route and shipments from the mills are progressing at a rate of approximately 200 cars of 26 miles of pipe a week.

One pipe-line construction crew has moved from its completed section of the Texas-Illinois leg of the line and will begin actual welding and laying on the extension within the next few days. A second crew is now enroute to its eastbound working site and others will begin operations periodically as additional sections of the right-of-way are fully surveyed and the exact route of the line staked out.

Approximately 250 miles of the route already have been staked by the 16 survey crews.

The 12 contractors, and the sections of work they have been awarded, are:

Spread No. 9. From Norris City, Illinois, to Oakland City, Indiana, 64 miles, Sheehan Pipe Line Construction Company, Tulsa, Oklahoma.

Spread No. 10. Oakland City to Paoli, Indiana, 54.5 miles, Ray L. Smith Construction Company, Eldorado, Kansas.

Spread No. 11. Paoli to Vernon, Indiana, 59.4 miles, Anderson Brothers, Little Rock, Arkansas.

Spread No. 12. Vernon, Indiana, to Middleton, Ohio, 65 miles, Anderson Brothers, Little Rock, Arkansas.

Spread No. 13. Middleton to Washington Courthouse, Ohio, 65 miles, C. S. Foreman Company, Kansas City, Missouri.

Spread No. 14. Washington Courthouse to Crooksville, Ohio, 60.5 miles, W. A. Bechtel Company, San Francisco, California.

Spread No. 15. Crooksville to Miltonsburg, Ohio, 50.4 miles, W. A. Bechtel Company, San Francisco, California.

Spread No. 16. Miltonsburg, Ohio, to Bristoria, Pennsylvania, 43.5 miles, O. E. Dempsey Construction Company, Tulsa, Oklahoma.

Spread No. 17. Bristoria to Connellsville, Pennsylvania, 43.5 miles, Williams Brothers, Tulsa, Oklahoma.

Spread No. 18. Connellsville to Macdonaldton, Pennsylvania, 43.5 miles, O. C. Whitaker Company, Fort Worth, Texas.

Spread No. 19. Macdonaldton to McConnellsburg, Pennsylvania, 43.5 miles, I. C. Little, Dallas, Texas.

Spread No. 20. McConnellsburg to Gettysburg, Pennsylvania, 43.5 miles, Oklahoma Contracting Company, Dallas, Texas.

Spread No. 21. Gettysburg to Lancaster, Pennsylvania, 43.5 miles, Oklahoma Contracting Company, Dallas, Texas.

Spread No. 22. Lancaster to Phoenixville Junction, Pennsylvania, 43.5 miles, Oklahoma Contracting Company, Dallas, Texas.

Spread No. 23. Phoenixville Junction, Pennsylvania, to Lambertville, New Jersey, 45 miles, Midwestern Engineering and Construction Company, Tulsa, Oklahoma.

Spread No. 24. Lambertville to Bayway and Bayonne, New Jersey, 17 miles, Jones and Brooks, Oklahoma City, Oklahoma.

Spread No. 25. Phoenixville Junction to Marcus Hook and Point Breeze, Pennsylvania, 45 miles, Exeter Construction Company, Camp Hill, Pennsylvania.

Ground survey contracts were awarded to: Huey and Cage, Monroe, Louisiana; Lockwood, Kessler and Bartlett, Brooklyn, New York, and Midwestern Engineering and Construction Company, Tulsa, Oklahoma.

Representatives of the contractors are now establishing field offices and warehouse locations. In addition, War Emergency Pipelines, Inc., which is supervising construction of the line for the government, has set up the following divisional headquarters for purposes of efficient operations control:

Division No. 1—Norris City to Mt. Sterling, Ohio, O. E. Stimson, construction superintendent, 401 First National Bank Building, Hamilton, Ohio.

Division No. 2—Mt. Sterling, Ohio, to McConnellsburg, Pennsylvania, D. S. Patton, construction superintendent, 525 Fayette Title and Trust Building, Uniontown, Pennsylvania.

Division No. 3—McConnellsburg, Pennsylvania, to Bayonne, New Jersey, George F. Brigance, construction superintendent, 603 Woolworth Building, Lancaster, Pennsylvania.

Less than 50 miles of main-line pipe remain to be laid on the Texas-Illinois leg of the 24-in. War Emergency Pipeline, according to an announcement by Petroleum Administrator for War Harold L. Ickes.

One of the seven construction crews lost six working days and another lost four during the last full work week in November, due to heavy rains and impassable right-of-way conditions along the northern sections of the pipe line, Administrator Ickes said, but satisfactory progress was maintained elsewhere to bring the total of "big inch" pipe in the ground to 473.63 miles. One contractor completed work on his main-line section over the last week-end, and will now devote full time to completion of approximately 50 miles of "feeder" lines around the Longview, Texas, terminal.

Paced by the on-schedule advance of welding and laying operations, the construction of pump stations and terminal facilities is also progressing rapidly, according to Deputy Petroleum Administrator Ralph K. Davies.

According to the progress report on the 24-in. line, continued bad weather has hampered completion of the "big inch" crossings on the Arkansas, Little Red, and Mississippi rivers, but preliminary welding and coating of pipe for river service is being pushed. A few days of good weather will permit rapid completion of these difficult and specialized construction jobs. Grading and foundation work at all 11 pump station sites is well underway and power transmission lines to five of the stations have been installed.

THE Petroleum Engineer

DECEMBER, 1942

Neoprene — A Construction Material For Petroleum Industry Equipment

PETROLEUM ENGINEER Exclusive

☆ Synthetic substitutes for natural rubber find wide application because of desirable characteristics

by C. C. Pryor

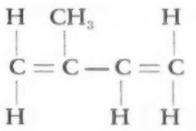
Associate Editor

RUBBER has become one of this Nation's most important construction materials. Its strength, toughness, resilience, and elasticity have simplified the job of design engineers in many of the peace and wartime industries. The present shortage of rubber for the manufacture of civilian and military products has caused a marked increase in the efforts of scientists who began 20 years ago to find a substitute embodying the same or similar qualities of natural rubber.

As the result of laboratory research there are a number of resilient products that are in many respects similar to natural rubber. Although none has the same composition as natural rubber and cannot, to be technically accurate, be called synthetic rubber, nevertheless, these resilient products are the only substitute for natural rubber and are equal and even superior in many qualities; thus they are called synthetic rubbers as a general term.

The synthetic rubbers may be divided into two general classifications due to their chemical composition. In the first classification are those synthetics that have an entirely different chemical composition from natural rubber. The plastic glyptal resins, a condensation product of a polybasic acid such as phthalic or adipic, with a polyhydric alcohol—glycerin or ethylene glycol; alkylene sulphides made by condensing ethylene dichloride or other dihalides with an alkaline polysulphide, such as sold under the trade name "Thiokol"; polyvinyl alcohol, and the plasticized polyvinyl resins such as those sold under the trade name "Koroseal" are those included in the first of the chemical classifications. Products from this classification have the rubber-like property of extensibility or deformability under relatively light loads. Some are vulcanizable within certain limits of the word —they become less plastic and more elastic when heated and even after vulcanizing the products are still definitely thermoplastic and under proper conditions may be remolded without altering their properties.

Synthetics with a chemical structure that closely resembles or approaches that of natural rubber in its primary constituent, *iso*prene, are included in the second classification. Beginning with the structural formula for *iso*prene,



the methyl group, CH_3, if replaced by a hydrogen atom, H, results in butadiene. Butadiene when polymerized, with or without the addition of modifying agents is known as the Buna rubbers. Replacing the methyl group by a chlorine atom, Cl, results in chloroprene. Polymerization of chloroprene produces the synthetic rubber known as Neoprene. In appearance and other physical qualities, the Buna and Neoprene synthetic rubbers closely resemble natural rubber. Compounded with other ingredients and vulcanized these synthetics lose their plastic tendencies and become elastic and resilient. Unlike natural rubber they are less susceptible to changes in properties with changes in temperatures.

The first synthetic rubbers developed

in the United States were specialty rubbers due to the inability of the manufacturers to compete with natural rubber prices at that time. The oil-resistant type of synthetic rubbers and others increased from about 2500 tons in 1939 to 4500 tons in 1940 and to about 9000 tons in 1941 with production capacity by the end of 1941 about 20,000 tons per year. These specialty rubbers were Neoprene by E. I. du Pont de Nemours and Company; Thiokol by Dow Chemical Company for Thiokol Corporation; Koroseal by The B. F. Goodrich Company, and Vistanex by Standard Oil Company of New Jersey.

Chemists had devised means for converting acetylene to divinylacetylene in 1927, however, they were unable to convert this material to the synthetic rubber, which was their objective. After it had been found that acetylene could be dimerized to vinylacetylene and then converted into substituted butadienes by additions at the acetylenic bond, development of the process for Neoprene was rapid. Means were found for the polymerization of acetylene to vinylacetylenes and chloroprene from vinylacetylene by addition of hydrocloric acid, which polymerized to a plastic rubber-like material. These developments were made by E. I. du Pont de Nemours and Company chemists. Beginning in 1931 the company entered commercial production of polychloroprene rubber, later termed Neoprene.

The hydrocarbon acetylene is of great importance in the production of Neoprene. Produced in large quantities from coal and lime by the calcium carbide process in electric furnaces it is important to note that acetylene is to be produced commercially from petroleum or natural gas under high temperatures. Two plants at present are being constructed—one to produce 27,000 tons of acetylene per year. It is believed that acetylene can be produced at lower cost from processing hydrocarbons than by the electrical method.

In 1935 du Pont was producing Neoprene in a plant with a capacity of 500 tons per year. Later enlarged to about 1500 tons per year, the plant was destroyed and replaced by a new plant with a capacity of 2000 to 2500 tons per year. By 1939 the company was producing about 7000 tons per year of Neoprene.

Neoprene compositions have found wide use in the petroleum and related industries in the construction of numerous pieces of equipment. One of the most serious obstacles or limitations encountered in the use of rubber in petroleum industry equipment has been the lack of resistance of rubber compositions to the deteriorating effect of petroleum hydrocarbons. Upon immersion of natural rubber products in a solvent, the volume changes due to the absorption of the solvent by the rubber. Although the change in volume or swelling of the rubber is not in itself of prime importance, the change in volume is often accompanied by serious deterioration in the physical properties of the product. Rubber that is swollen with oil loses its tensile strength and its toughness and abrasion resistance are materially reduced. Measurement of the volume increase after immersion in oil of natural rubber, Neoprene, and other synthetic rubbers cannot be used as an evaluation yardstick because there is no definite relationship between the degree of swelling and changes in other properties of Neoprene or rubber. Neoprene has been found to exhibit the strength, toughness, elasticity, and abrasion resistance of natural rubber with the one additional characteristic of such importance to the manufacture of oil-industry equipment—a greater inherent resistance to immersion effects of oil over natural rubber and so-called oil-resisting rubber. Other qualities of Neoprene such as resistance to oxidation, sunlight, heat, chemicals, and flame are also important to the oil industry.

To impart the properties desired for specific service conditions to the finished product, manufacturers of commercial rubber products mix sulphur, reinforcing pigments, fillers, and organic compounds with the rubber. One of the fundamental differences in the technique of compounding rubber and Neoprene is that the synthetic, unlike rubber, does not require sulphur for vulcanization. Sulphur is included in some of the compounds to give the mix certain characteristics. The sulphurless compounds are of special use in intimate contact with materials that are attacked by sulphur.

The specific gravity of Neoprene it-

Fig. 1. Neoprene polymer being removed from the polymerization kettle

self is 1.25. A majority of Neoprene compounds have specific gravities ranging from 1.40 to 1.80 due to the addition of pigments. Compounds with large proportions of pigments may have a specific gravity as high as 3.00.

The tensile strength of Neoprene rubber is comparable to that of like compositions of natural rubber. An ultimate tensile strength of the compounds may be formulated from 200 to 4000 lb. per sq. in. depending on the ingredients and amount in the compound. Under severe abrasion conditions Neoprene has displayed an advantage over rubber due to its superior resistance to deteriorating influences. Under ordinary conditions of service abrasion resistance of Neoprene and rubber is about the same. In other tests Neoprene has been found to possess many characteristics either superior or equal to those of rubber. Included in this long list is tear strength, diffusion of gases, hysteresis characteristics, vibration absorption, permanent set or deformation, thermal conductivity, resistance to inorganic chemicals, refrigerants, halogens and halogen-substituted hydrocarbons, organic chemicals, and water.

Among the many uses of Neoprene in equipment for the petroleum industry is the rotary hose. One of the most important pieces of equipment on the drilling rig, it is essential that only the

TABLE I

***Effect of petroleum swelling agents**

IMMERSED IN	Percent volume increase when immersed at 82° F.			Percent volume increase when immersed at 212° F.		
	Compound	3 days	7 days	4 days	6 days	8 days
Crude oil:						
Pennsylvania	N[1]	7.0	9.6	20.7	20.7	20.7
	R[2]	55.0	58.7	261.0	Disintegrated	
Mid-Continent	N	11.2	20.2	70.0	74.2	75.6
	R	55.4	61.3	214.0	Disintegrated	
Gulf Coast	N	9.3	18.1	91.0	101.0	102.5
	R	31.6	54.2	342.0	478.0	Disintegrated
Spindle oil:						
From Pennsylvania crude	N	3.6	5.7	20.4	22.6	22.6
	R	20.2	33.4	Disintegrated		—
From Mid-Continent crude	N	5.9	9.2	44.3	49.2	49.2
	R	29.2	46.1	349.0	Disintegrated	
From Coastal crude	N	10.1	13.9	78.0	86.0	98.5
	R	29.6	51.7	410.0	Disintegrated	
Motor oil, SAE No. 30:						
Type 1	N	1.4	1.4	8.4	9.9	9.9
	R	6.9	11.0	107.7	131.3	156.8
Type 2	N	2.2	3.1	39.1	41.5	44.7
	R	10.2	15.5	199.3	260.0	328.0
Type 3	N	0.9	0.9	10.7	12.3	13.3
	R	6.4	10.7	90.3	116.2	140.3
Motor Gasoline	N	29.2	33.0	—	—	—
	R	84.0	88.5	—	—	—
Casinghead Gasoline	N	8.9	8.9	—	—	—
	R	56.5	58.0	—	—	—
Petrolatum	N	—	—	15.4	17.6	17.6
	R	—	—	114.2	149.2	178.3

*Resilient Materials of Construction for the Petroleum Industry by H. Logan Lawrence, E. I. du Pont de Nemours and Company, Inc.
[1]Neoprene.
[2]Rubber.

Fig. 2. Rotary hose covered and lined with Neoprene in use on drilling rig

Fig. 3. Stripper rubbers of Neoprene used because of oil and abrasive resistance qualities

Fig. 5. Neoprene-lined dock hose resists deterioration of oil and gasoline

best material be used in its construction. Rubber constitutes only a small portion of the hose—the inner lining. The advantages of the Neoprene-lined hose and the rubber-lined hose were apparent in the longer life of the Neoprene-lined hose. Instances have been recorded where the Neoprene-lined hose gave twice the serviceable life as did the rubber-lined hose. Oil-field mud pumps are subjected to severe service in drilling. The piston rubbers, valve inserts, and sleeve packing in the slush pump are in contact with drilling fluid, oil, mixtures of both, and some abrasive materials. One operator who switched to Neoprene pistons more than doubled the operating time between replacements. During one year an acidizing and cementing company pumped more than 500,000 gal. of acid, 2,000,000 gal. of oil, and 250,000 gal. of water and cement with Neoprene pistons without a failure. A tubing stripper of Neoprene had 52,000 ft. of drill pipe in which there were 1300 collars run through it and after inspection was found to be worn so little that it could be continued in service.

Fig. 4. These slush pumps utilize Neoprene pistons for pumping oil and drilling fluid

Manufacturers of back-pressure regulators have found the diaphragms made of Neoprene give longer trouble-free life. Full advantage has been taken of Neoprene in the manufacture of stripper packoff rubbers in certain types of blowout preventers. Neoprene-bound fabric cups have been tested in pumping wells with the result that they lasted twice as long as ordinary rubber-bound cups. Thus an important saving in workover time is realized by operators of pumping wells.

Neoprene packer elements have been found highly successful for use in wells producing sour crude oils. Such packer rubbers do not deteriorate or stick to the casing and may be removed without difficulty for salvaging or resetting. These products and numerous others in wide use in the petroleum industry have benefited from the use of Neoprene substituted for natural rubber.

Tremendous advances have been made in rubber technology, which have broadened the field for rubber products because the advances have imparted to the products a greater ability to retain their original useful properties resulting in longer life under all service conditions.

Photographs and material supplied by E. I. du Pont de Nemours and Company

☆ ☆ ☆

Valve Repair Conserves Essential Metals

☆ Details given of steps necessary to keep equipment in good working condition

THE difficulty of obtaining new valves due to the war's demand for raw materials from which they are made, makes it necessary for users in all branches of the petroleum and related industries to repair leaky valves and even reclaim discarded valves that have already given years of service.

When it is definitely known that a gate valve is leaking at the seats, an immediate examination should be made to determine why. Neglected leaks eventually damage seating surfaces beyond repair. In new installations, leakage may be due to dirt or pipe scale. Immediate inspection and cleaning may prevent serious damage. A gate valve often can be repaired while still in the line, although removing and working on it at a bench is much more convenient. Accompanying illustrations depict the various steps required in repairing valves.

After the bonnet is removed from a gate valve, the disk and body should be cleaned and examined thoroughly. (Fig. 1.) Carefully determine the extent of damage to body rings and disks. If corrosion has caused excessive pitting or eating away of metal, such as destruction of guide ribs in the body, it may be impracticable to attempt repairs.

A complete checkup and servicing of all parts of the valve are recommended. Remove the stem from the bonnet and examine it for scoring and pitting where the packing bears. Usually light polishing with fine emery cloth will put the stem in good condition. (Fig. 2.) Use "soft" jaws if the stem is put in a vise.

Next, remove all old packing and clean out the stuffing box. (Fig. 3.) At the same time, clean the inside of the valve bonnet, as well as other parts, of dirt, scale, corrosion, etc., to prevent such foreign matter from getting into the valve seats.

It doesn't pay to salvage an old gasket, therefore, remove it completely and replace with one of proper kind and size.

If, after cleaning and examining all parts, it develops that repair can be made by removal of cuts from the disk and body seat faces or by replacement of body seats (the disk frequently can be saved even though cut deeply, as replacement body seat rings are provided with a slightly heavier shoulder to compensate for excessive wear on the disk), proceed as follows: Set the disk in a vise with the face leveled. (Fig. 4.) Wrap a piece of fine emery cloth around a flat tool and rub or "lap" the entire bearing surface (both sides of disk) to a smooth, even finish. Remove as little metal as possible. The usual cuts and scratches found on body rings can also be repaired by "lapping". Use an emery block small enough to permit convenient rubbing of the rings all around. (Fig. 5.) Work

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

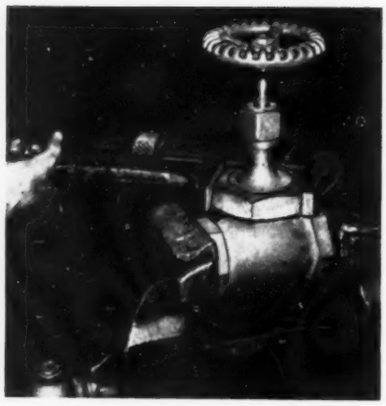


Fig. 6

Fig. 7

Fig. 8

carefully; avoid removal of too much metal, as this will result in the disk seating too low. When seating surfaces (disk and body rings) are properly "lapped-in" coat the faces of the disk with Prussian blue and drop it in the body to check the "bearing". When a good continuous contact is obtained the valve will be tight and is ready for reassembly. To assemble, first insert the stem in the bonnet, install new packing, assemble other parts, attach the disk to the stem, and place the assembly in the body. Before tightening the joint raise the disk to prevent contact with the seats so that the bonnet can be properly seated on the body.

When seat rings in gate valves must be replaced, they can be removed and replaced best with a power lathe. Chuck up the body with the rings vertical to the arbor and use a strong steel bar across the ring lugs to unscrew them. Removal by hand can be done with a diamond point chisel, being careful not to damage the threads. The new rings must be "socked home" tight. A large wrench on a steel bar across the lugs will help when rings must be put on by hand. Always coat the lug threads with a good lubricant before the rings are put in. Lap-in the rings for a perfect fit to the disk. (Fig. 5.)

Globe and Angle Valves

Repairs to globe and angle valves usually can be made without removing them from the line, encouraging immediate repair when a leak occurs and thus preventing serious damage.

When re-grinding a globe valve at the bench, set it firmly in a vise, straight up. (Fig. 6.) Use "soft" jaws to prevent damage to the body. It is best not to use a pipe wrench on the bonnet or union ring. A monkey wrench will not damage these parts.

While the parts are disassembled, examine and clean them thoroughly. Remove the stem from the bonnet by placing the disk in a vise and unscrewing the disk stem ring. Next, lift out the stem and insert a coin or slug inside the disk. (Fig. 7.) Replace the stem and tighten the disk stem ring. The slug or coin takes up "play" between the disk and stem. In some valves, a pin is inserted in the hole provided to lock the disk on the stem. Before grinding apply an emery base grinding compound to the disk and to the seat. Do not apply too much compound; it is wasteful and also may remove too much metal. (Fig. 8.)

Place the bonnet and body together, giving the bonnet or bonnet ring two or three turns by hand to provide a guide for the stem. (Fig. 9.) With a firm hold oscillate the handwheel steadily until all pitting is removed and a continuous, smooth bearing on the seating surfaces is obtained.

When grinding is finished, wipe the disk, seat, and body clean of all compound and dirt. (Fig. 10.) Before reassembling the valve, be sure to remove the slug or coin from the disk to give it free swivel action on the stem.

When seat rings must be removed it is desirable to use a tool specially designed for this purpose; to do so will prevent damage to the valve body.

Acknowledgment

Information contained in this article, and photographs, were provided by Crane Co., Chicago, Illinois.

☆ ☆ ☆

Fig. 9

Fig. 10

Steel Permitted in Oil-Well Pumping Units

Oil-well pumping units have been removed from the list of items in which the use of steel is prohibited by Conservation Order M-126 as amended December 5 by the Director General for Operations.

This action was taken on the suggestion of the Petroleum Administrator for War. The units, essential in the production of oil, must be made of either steel or high-grade wood. Manufacturers have been unable to obtain the type of lumber required.

P 511.222.
P 518.

Rate of Withdrawal, Its Effect on Water Encroachment in the East Texas Field[1]

PETROLEUM ENGINEER Exclusive Feature

☆ Surface and bottom-hole chokes utilized to control rate of production, retard water encroachment, prolong life of wells, and increase ultimate recovery

by J. N. Miles

Division Production Engineer, East Texas Division, Cities Service Oil Company

THE rate of water encroachment in the East Texas field is one of prime importance to all operators and every method of controlling it should be well understood. The purpose of this article is to discuss the effect of the rate of production upon the rate of water increase during the productive life of a well and some possible aids in its control.

The time of the appearance of the first water and its rate of increase is dependent upon several factors such as sand thickness, penetration, oil-water interface, permeability, shale lenses, and rate of production. An operator has no control over most of these factors and consequently must apply his efforts to the ones that he does have some control over, such as penetration and rate of production. Most of the wells in East Texas have been completed several years and they may have been drilled deep into the producing sand or only a few feet. If the penetration is in the order of 10 ft. or more, the opportunity for a successful plug-back job is good and should be given serious consideration. The rate of fluid production is another important means of controlling the rate of water encroachment and many of the factors involved will be discussed in the following paragraphs.

Water underlies the oil on the west side of the East Texas field and is a constant source of possible trouble as well as being the principal motivating force for bringing oil into the well bore. When a well is drilled into the producing formation oil enters the hole due to a difference in pressure between the formation and well bore. The greater this difference in pressure, the farther from the well bore will its effects be noted. In a homogeneous sand, the pressure contours would take the general shape of a semi-circle around the well bore (Fig. 1). Fortunately a homogeneous sand is seldom found, so in most cases the horizontal permeability is much greater than the vertical permeability and the pressure contours extend much farther horizontally from the well bore than vertically. (Fig. 2.) This does not alter the fact that the greater the production rate, the greater the pressure differential around the well bore and thus the increased possibility of water intrusion.

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graduated from the University of Oklahoma in 1933 with B.S. degrees in petroleum engineering and mechanical engineering—Worked one year in the Seminole field, Oklahoma, as a roustabout for the Gypsy Oil Company—Seven years for the Cities Service Oil Company at Oklahoma City; Eldorado, Kansas; Russell, Kansas; Great Bend, Kansas, and Gladewater, Texas, as a production engineer—Is now division Production Engineer, East Texas Division—Is a member of the A.I.M.E. and a registered professional engineer in Texas.

Water Coning

Fig. 3 illustrates how water-coning occurs in a well and traps oil in the formation, preventing it from being produced. The degree of coning and the quantity of oil trapped depends on the sand thickness, well penetration, and producing rates employed during the life of the well. The first indication of coning is a slight rise in the water level below the well bore. At this time no water is produced with the oil. The next phase is indicated by small globules of water percolating through the oil sand into the well bore from below, by which time the water level has risen and water-coning becomes more pronounced. Also at this point the rate of production begins to increase in order to handle the additional fluid. The third phase shows a part of the sand around the well bore to be completely saturated with water and the cone more pronounced. The final phase shows the sand around the well bore to be completely saturated with water and the only oil produced at this time is washed in with the water. There is still an appreciable oil zone but there is no way for the oil to enter the well. To obtain all the oil large volumes of water must be produced. If the water cone is kept depressed by slow withdrawal rates, more oil is recovered and less water is produced.

Production Rates

To obtain some idea of the proper producing rates refer to Fig. 4.[2] This chart shows the relationship of maximum rates of flow to oil-zone thickness and well penetration into the oil zone without causing water coning in a homogeneous sand. This can be exceeded in most cases because of bedding planes and shale lenses below the bottom of the well bore. As an example, if the thickness of the oil-zone is 15 ft. and is penetrated by 10 percent or 1½ ft., the maximum rate of production without raising the level of the underlying water table is approximately 25 bbl. per day. If the penetration is 67 percent or 10 ft., the maximum rate without the coning effect is about 10 bbl. per day and if the penetration is 90 percent or 13½ ft. the maximum rate becomes 2½ bbl. per day. If the oil-zone has a thickness of 50 ft. and

[1]Preprints of this article were supplied by *The Petroleum Engineer* for presentation by the author before the East Texas Chapter of A.P.I., Division of Production, at Kilgore, Texas, December 8, 1942.

[2]Adapted from M. Muskat and R. D. Wykoff. "Approximate Theory of Water Coning and Oil Production," *Transactions A. I. M. E., (1935)*, Vol. 114, p. 156.

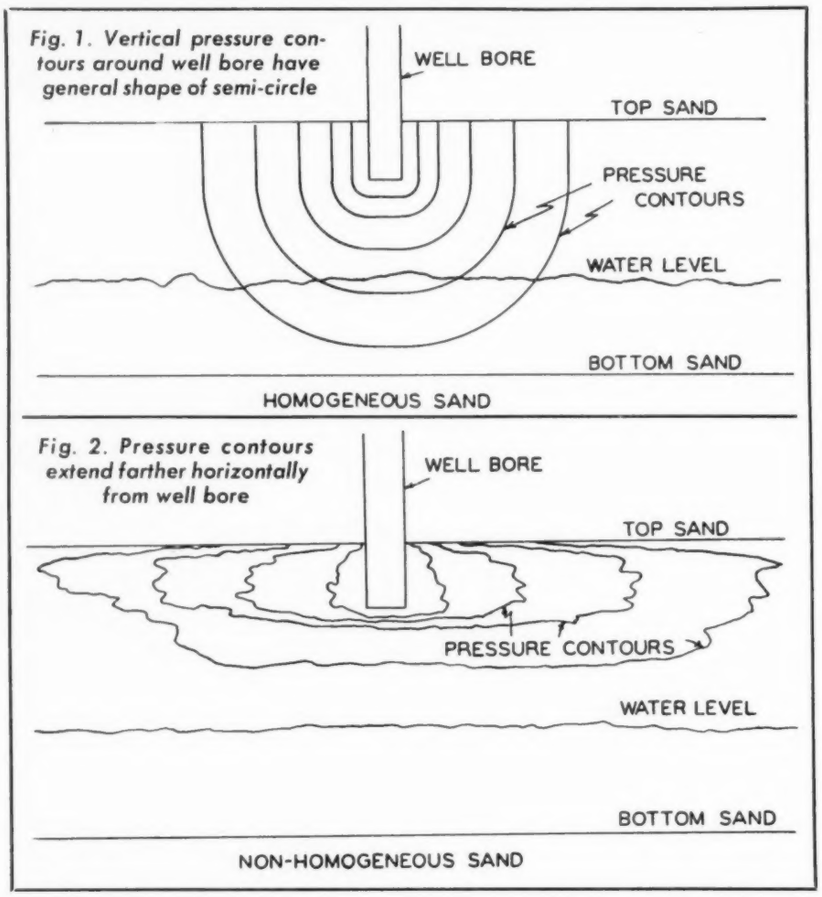


Fig. 1. Vertical pressure contours around well bore have general shape of semi-circle

Fig. 2. Pressure contours extend farther horizontally from well bore

a penetration of 10 percent or 5 ft., the maximum rate of flow is about 350 bbl. per day before elevation of the water table. If penetrated 70 percent or 35 ft. the maximum rate is about 130 bbl. per day. All the maximum producing rates just mentioned must be distributed throughout the 24-hour period. Any restriction in the vertical permeability, due to shale lenses or other causes, between the bottom of the hole and the water level, will increase these maximum rates by a considerable amount, say in the order of 50, 100, or 200 percent.

If it is agreed that the rates of production must be maintained at a minimum, there arises the question of the most feasible means of doing so without incurring too much expense. In flowing wells, it is comparatively simple, for either bottom-hole or surface chokes can be employed and rates of production held to a minimum. Very low rates of flow without water being present with the oil are conducive to paraffin accumulation in the tubing and more frequent trips with the paraffin knife are necessary; however, chokes and low rates of flow should be employed on the west side or in any area subject to early water encroachment. In the case of pumping wells there are several corrective measures that can be taken, such as the use of small pumps, surface chokes, or bottom-hole chokes. Small pumps used in conjunction with short strokes and slow pumping speeds permit slow withdrawal but require long pumping hours and consequent added expense. In addition, the hazard of the well "heading" and flowing at high rates for short periods is always present. It is believed that this last factor is one of the reasons that wells increase rapidly in water production shortly after going on the pump. The surface choke used in conjunction with pumping wells prevents heading but does not reduce the withdrawal rate below the pumping rate, although it has a tendency to plug and also to cause emulsions and decrease pump efficiency.

Bottom-Hole Chokes

Two types of bottom-hole chokes are used. One is the tubing type in which the choke is screwed into the tubing string below the pump. The other is a removable type that is attached to the standing valve or insert pump and can be pulled with the rods. (Figs. 5 and 6.) In both cases, a packer is employed between the tubing and casing. The tubing is perforated between the choke and the standing valve, which permits the annular space between the tubing and casing to be used

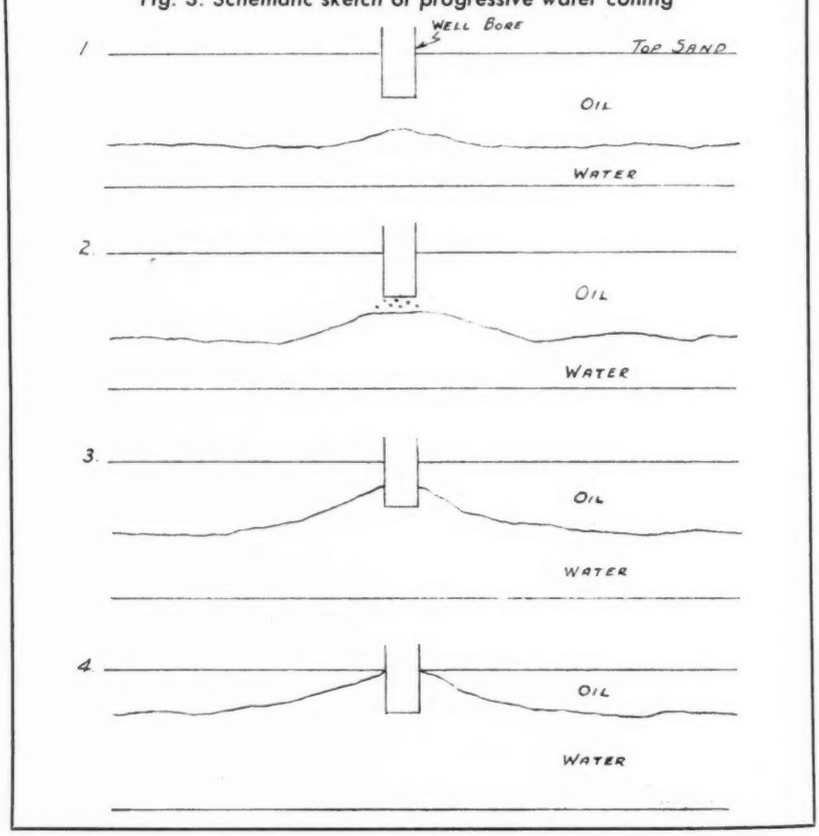


Fig. 3. Schematic sketch of progressive water coning

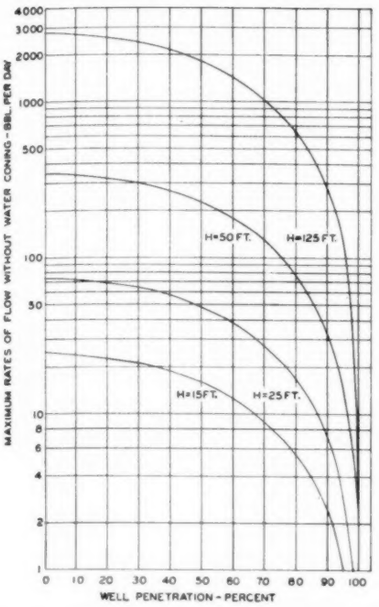


Fig. 4. Maximum rates of flow without water coning based on well penetration and sand thickness. H = sand thickness

as a storage chamber. In this way, a choke size can be chosen that will limit the withdrawal from the formation to a few barrels per hour whereas fluid from the annulus can be produced at a rate of 20 or 30 bbl. per hour. In addition, the rate of withdrawal is not affected by a pumper in need of some quick production.

The choke size is very important and consideration should also be given to the well capacity or productivity index, rate of withdrawal desired, pump depth, and size of casing and tubing installed. Reference is made to Fig. 7, which illustrates the means of choosing the proper choke size to install. If the rate of production desired and the approximate fluid level are known the proper size choke can be chosen from the graph. In the East Texas field, where fluid levels on the west side are 2000 to 3000 ft. from bottom, a $\frac{1}{16}$-in. choke would permit a production of from 60 to 75 bbl. of fluid per day if the annulus were kept pumped down. In intermittent pumping, however, the rate of fluid entry per day would be reduced due to the annulus filling and reducing the pressure differential across the choke. If 60 or 70 bbl. per day were desired, then the next larger choke size should be chosen.

In larger casing sizes it is possible that the force exerted by the formation pressure against the bottom of the packer might unseat the packer if the annulus were pumped dry, because the total force exerted upward would be greater than the weight of the tubing and liquid in it acting downward. In that case, the packer could be moved 500 ft. or so upward and the lower part of the tubing hung below the packer. This would reduce the storage capacity in the annulus and thus would require a larger choke, slower pumping, or both.

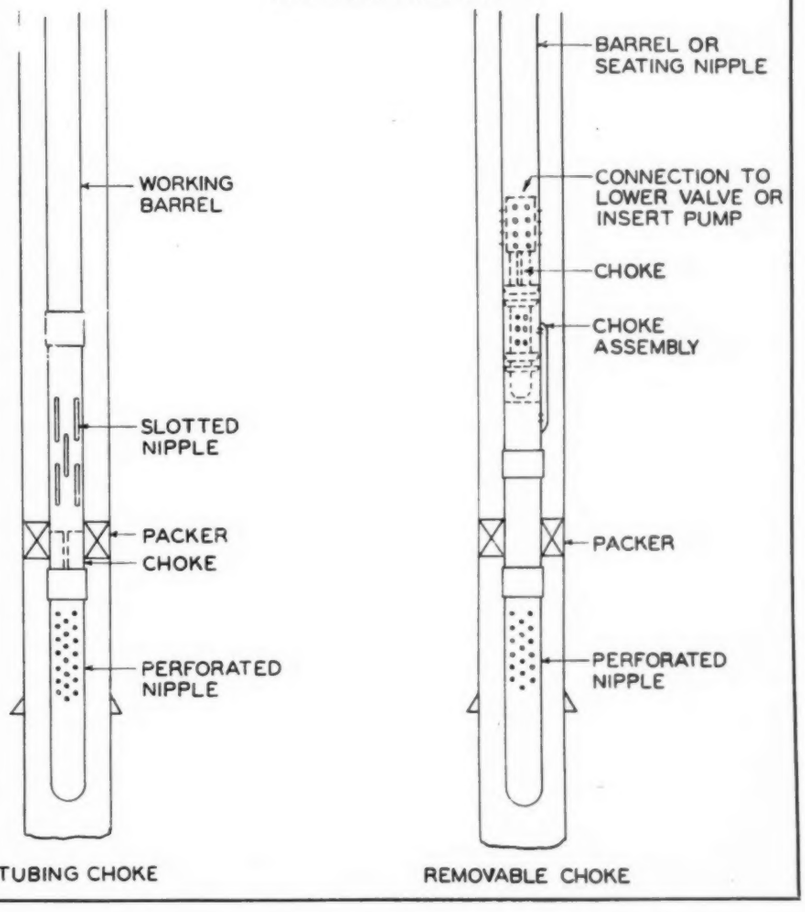
Choked and Unchoked Wells

Fig. 8 shows the relationship of water increase between a group of 30 unchoked wells and 34 choked wells. As can be seen, the rate of water increase for the choked wells has been much slower than the wells that were not equipped with chokes. At points on the two curves, which represent the cumulative production of 20,000 bbl. of oil, and after the first appearance of water, the unchoked wells averaged 81.5 percent water and each had an average production of 22,800 bbl. of salt water. At the same point in cumulative oil production the choked wells then averaged 51 percent water and each well had an average total production of 8010 bbl. of salt water. Even should no additional oil be obtained by the use of chokes, the reduction in total volume of water lifted and then injected would much more than pay for the installation of the choke.

The wells with chokes installed have not been abandoned as yet and so their future life is uncertain. Based on their past behavior, however, the rate of water increase has been extended to 76 percent water, at which point the average choked well is showed to have produced 2000 more bbl. of oil than an unchoked well during its entire life. An ultimate recovery of 8,000 to 10,000 bbl. more of oil is probable from the choked well compared with the unchoked well. Some engineers expect a greater difference than this.

It is believed that the proper time to install a choke is early in the water-producing history of a well, or better yet, if water is known to be near, the choke can be installed before any water is produced from the well. A choke can be installed, however, and the well helped in most cases if done before the water production exceeds about 60 percent. There are some instances of wells being aided by the installation of chokes after higher percentages of water have been produced, but these wells generally have been penetrated to a considerable depth into the sand and have been pro-

Fig. 5 (left) and Fig. 6 (right). Two types of bottom-hole chokes used in East Texas field



duced at comparatively high rates. The cost of a trial is not great and it may be advisable to try it on many wells now producing large volumes of water.

Choke Installation Results

One lease in the East Texas field has had a very interesting history in respect to choked and unchoked wells. The first four wells on this lease that began making water did not have chokes installed when they were put on the pump. Their rate of water increase was very rapid until they were producing 400 or 500 bbl. of water each per day. They were plugged after the oil had decreased to about 4 or 5 bbl. per day but in the meantime they had produced large volumes of water. The other wells on the lease had chokes installed when they were put on the pump and when they became marginal, after a much slower rate of water increase, they were producing about 100 bbl. of gross fluid per day. It was thought that if larger chokes were installed and more fluid produced the oil production would increase to 20 bbl. per day again, so larger chokes were put in and the gross fluid was increased to 170 bbl. per day but the oil production remained the same. Then the chokes were removed and 300 to 400 bbl. of gross fluid was produced but the oil production still remained the same. The original chokes were put back in, reducing the total fluid to 100 bbl. per day, and the oil production was the same as at first. Two of these wells were depleted to about 2 or 3 bbl. of oil per day with a gross fluid withdrawal of 100 bbl. with the chokes being used. The chokes were removed for a final test before plugging and the fluid withdrawal increased to 400 bbl. per day. Oil production remained the same. The above results indicate that it may be possible to deplete an East Texas well, by the use of chokes, and the well not be required to produce more than 100 bbl. of water per day.

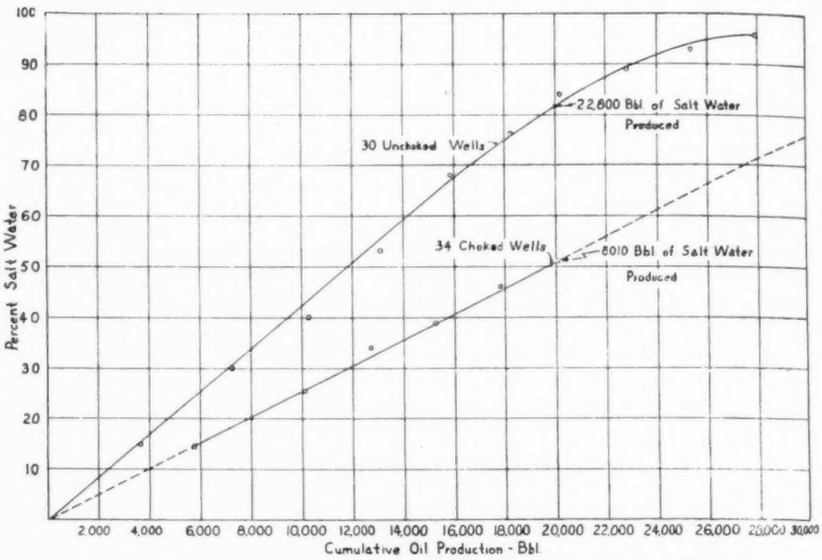
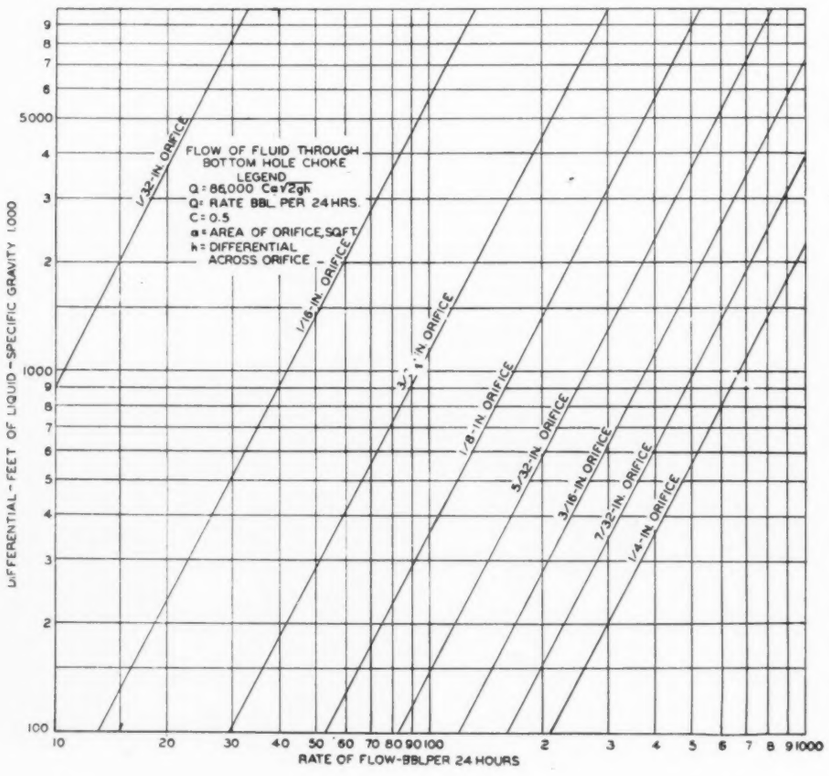

Percent Salt Water
Cumulative Oil Production - Bbl
22,600 Bbl. of Salt Water Produced
30 Unchoked Wells
34 Choked Wells
8010 Bbl. of Salt Water Produced

Fig. 8. Comparison of salt water production with cumulative oil production from wells producing with and without bottom-hole chokes. Salt water figures given are for 20,000 bbl. of oil produced

Fig. 7. Illustrating the means of choosing proper size choke to install



Conclusions

1. In areas where water underlies the oil in the same sand, the rate of production affects the rate of water encroachment into the well bore.
2. The rate of production can be held to a minimum in both flowing and pumping wells by the use of surface or bottom-hole chokes.
3. In the East Texas field the additional production per well from the use of bottom-hole chokes may be as much as 10,000 bbl. of crude oil.

The Gulf Oil Corporation has made a more extensive use of bottom-hole chokes in pumping wells and probably has more installations than all other operators combined in the East Texas field. The recent experience of many operators will undoubtedly lead to the more widespread use and a better understanding of the use of bottom-hole chokes as a production practice. At this time there are 350 or more chokes installed in the East Texas field.

Acknowledgement

The author wishes to acknowledge the help of F. J. Mikeska of the Gulf Oil Corporation, J. E. Bailey of the Tide Water Associated Oil Company, R. J. Dobson of the Shell Oil Company, and Paul Coonrod of the Mid-Continent Pump Supply Company. In addition, the author wishes to thank the Cities Service Oil Company for permission to present this material.

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Welders running finishing beads on 12-in. pipe

PETROLEUM ENGINEER Exclusive Feature

Gas Lines Laid of Salvaged Pipe

☆ Lines taken up, reconditioned, and relaid at points of greater strategic value—methods employed

by Frank H. Love
Managing Editor

WITH a view to utilizing its facilities where most needed during the present emergency, the Lone Star Gas Company has taken up several pipe lines in West Texas, reconditioned the pipe, and is relaying it at more strategic points where increased gas volume is required for winter consumption. The pipe being taken up is from parallel lines and is in places where the remaining lines can adequately supply the consumer demand in the areas they serve.

Thirty-seven miles of 18-in. pipe, Dresser coupled, is being laid from a point between Lancaster and Duncanville, at a junction of two of the company's existing lines, and extends southeast to a point 9½ miles east of Alma in Ellis County. This line parallels 37 miles of the 20-in. line extending from Irving to gas fields at Cayuga, Long Lake, and Grapeland. Pipe for this project was taken from the line between Gordon and Waples Switch, the latter near Granbury.

A line that will consist of 28 miles of 12-in. and 3⅓ miles of 10-in. pipe when completed, originates about 6 miles west of Dew and continues to Groesbeck. This ties into and parallels the Long Lake to Waco 12-in. line of the company.

Beginning 12 miles west of Dew, 4 miles of 8-in. pipe is being laid to Teague to connect with an existing line; and another 8-in. line originates just north of Groesbeck and extends 9.7 miles northward.

The 10- and 12-in. pipe is being taken up in the Ranger district and the 8-in. near Coleman in the Ballinger district.

Coating and wrapping 12-in. pipe with a traveling-type machine

Reclaiming Pipe

In removing pipe from the ground it is uncovered by conventional - type ditching machines and pulled from the

trench by tractors equipped with booms and winches. No attempt is made to clean the pipe as it is taken up; it is hauled by truck immediately to numerous points convenient to the laying operations.

The 18-in. pipe is being taken to four points on the right-of-way and there reconditioned in central yards. As the dirty pipe is brought to the yard it is stacked at a location convenient to a stationary-type cleaning machine, which removes rust, scale, dirt, etc., and leaves the pipe in condition for inspection. Sections of pipe considered too badly corroded to be of further use are removed by torch-cutting and pits that are one-half the wall thickness of the pipe in depth are marked for spot welding. After passing through a second cleaning machine with primer head attached, the pipe is racked ready for transportation to the right-of-way.

Reconditioning Couplings

Cleaning the couplings constitutes a separate operation. To perform this work a steel-wire buffer operated by compressed air is provided. When all scale and dirt have been removed a primer paint is applied by hand and the various parts of the couplings matched and made ready for use. A special machine also has been provided to straighten the followers, many of which are bent egg-shaped when the pipe is pulled from the ground in taking-up.

In laying the line, the pipe is again primed and hot enamel coating and asbestos-felt wrapper applied. These are applied before the couplings are installed, and to make it possible for the traveling-type coating and wrapping machine to operate continuously, a sleeve-like affair termed a "Dutchman" is slipped over the ends of the pipe to hold the joints together. This equipment is made by welding two center rings of a coupling together and is just enough larger than the outside diameter of the pipe to permit it to fit snugly over the pipe ends and allow the coating and wrapping machine to pass along the pipe uninterruptedly.

After the couplings are installed they are "doped" by hand with a special pipeline service cement.

Handling Smaller Diameter Pipe

The smaller diameter pipe, the 8-in., 10-in., and 12-in., is cleaned on the line. The stove-pipe method of construction is employed, and after the joints have been electric-welded into the line with three beads a traveling-type cleaning machine is passed over the pipe. To this machine is attached a primer head with the coating and wrapping machine following at a short distance. Lowering-in and backfilling are done in the customary manner.

All pipe, regardless of size, is being given a 24-in. covering.

River Crossings

On the 12-in. section one river has been crossed, the Navasota. This stream, however, is not navigable and not very wide and the crossing was made without difficulty. After the joints were welded together the string was pulled into place by tractors equipped with winches. No river clamps were required.

A part of the pipe used in laying the lines herein discussed had been in use 17 years, some of it about 12 years. On the whole it was in exceptionally good condition when taken up and very little had to be junked.

The B. and M. Construction Company, Oklahoma City, Oklahoma, is the general contractor for the 18-in. line, and Allen and Sharman, Houston, Texas, for laying the 8-, 10-, and 12-in. pipe. The takeup and reconditioning work is being done by Lone Star Gas Company personnel.

Top—Cleaning pipe on the line with a traveling-type machine. Center—Cleaning 18-in. pipe in central yard with stationary-type machine. Bottom-Couplings reconditioned and stacked ready to be moved to the right-of-way

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Minute Men at Home, Too

The Minute Man Flag of the U. S. Treasury Department flies over the Cooper-Bessemer plant at Mt. Vernon, Ohio. It signifies that 100% of the employees are buying War Bonds and that 10% of the company's payroll is so pledged.

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New Type Casing Protects Pipe Line At Road Crossings

FOR years United Gas Pipe Line Company has been experimenting with various methods of protecting its pipe lines from damage at minor road crossings caused by county road graders. Contact of the grader blade with the pipe occurs infrequently, but when it does it may cause an immediate violent blowout, or it may nick and chop the pipe to such an extent that the break comes later at an unexpected moment.

If every county road crossing could be handled in the same manner as a highway, that is bored and cased, this would not occur. Such a procedure is not practicable, however, as it would require years of work, hundreds of miles of pipe, constant maintenance, and frequent changes as new roads were made.

Recently in the Monroe, Louisiana, district a crew of United workmen under supervision of Tom Mussett tried a new type of "casing" to protect these road crossings. It appears to be the most economical and effective protection yet devised.

Pipe of larger diameter than the pipe to be protected is split into two pieces lengthwise. The protective section of pipe is slightly longer than the portion of pipe to be protected. The split halves are placed around the pipe and welded together. The casing is coated on the inside and outside but is not fastened to the line in any manner.

To test the workability of their idea, Mussett's crew enlisted the service of a county road grader. Coming in with the blade low and at a high rate of speed for a grader, the driver struck the casing. The protective casing was pierced, but the initial shock of the blow rolled the casing slightly and the pipe itself was not damaged. Several such tests were made and all were successful.

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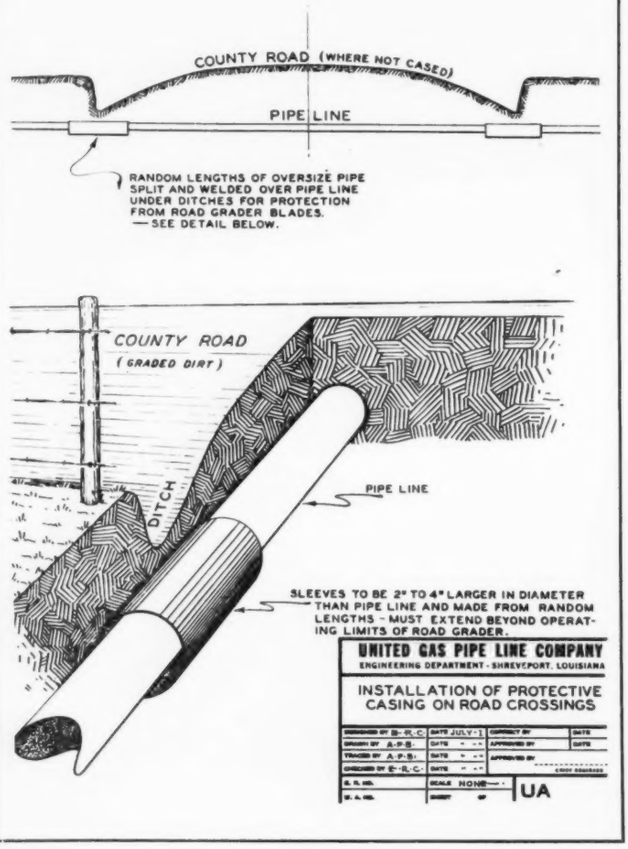
Pipe-line crossings at county roads are sometimes struck and damaged by graders

Diagram showing method of installing sleeve to protect pipe line at road crossing


COUNTY ROAD (WHERE NOT CASED)
PIPE LINE
RANDOM LENGTHS OF OVERSIZE PIPE SPLIT AND WELDED OVER PIPE LINE UNDER DITCHES FOR PROTECTION FROM ROAD GRADER BLADES. —SEE DETAIL BELOW.
COUNTY ROAD
(GRADED DIRT)
DITCH
PIPE LINE
SLEEVES TO BE 2" TO 4" LARGER IN DIAMETER THAN PIPE LINE AND MADE FROM RANDOM LENGTHS - MUST EXTEND BEYOND OPERATING LIMITS OF ROAD GRADER.
UNITED GAS PIPE LINE COMPANY
ENGINEERING DEPARTMENT - SHREVEPORT, LOUISIANA
INSTALLATION OF PROTECTIVE CASING ON ROAD CROSSINGS
DRAWN BY B-R-C
DATE JULY-1
TRACED BY A-P-B
CHECKED BY E-R-C
SCALE NONE
UA

Chalk mark shows how casing moved and where it was struck by blade of grader. Inset shows results of three hits by grader, one of which pierced the casing but not the pipe

Shown during test at the factory—the first two of fifteen squirrel-cage motors (rated 1500 hp, 1800 rpm, 2300 volts) for use on the 24-inch War Emergency pipeline from Texas to Illinois.

MOTORS *5 weeks ahead of schedule* for the BIG-INCH pipeline

—that's General Electric's production record for the first two motors which will operate pumps on this impressive project. The Company expects to beat the scheduled time in supplying additional motors as well.

General Electric offers a complete line of electric equipment for pipe lines, backed up by experienced engineers to apply it, the "know how" to meet your particular problems, adequate facilities, and an enviable record in wartime production. *General Electric Co., Schenectady, N.Y.*

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Control equipment for four pumping stations, transformers for five stations, and auxiliary pump motors for the "Big-Inch" pipeline are also under construction by General Electric.

Solution of Pumping Problem Aided by Use of Tabular Data

Problem typical of those encountered in the field solved by tables and simplified calculations, illustrating value of method to the field man and engineer

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

R. G. LOVELL

SOLUTION of pumping problems by employing tabular data presents the field man or engineer a direct route to the answer to his problem. These tabular data, however, must at times, be gathered from two or more tables. This is necessary, not because the tables themselves are incomplete but because most refinery pumping problems are complex and, consequently, require consultation of several sources, each having to do with one or more phases of the problem.

The solution of a pumping problem, representative of those commonly occurring in the field, by the use of tables and simplified calculations may be of value to the field man and engineer.

Following is the statement of a problem from a field engineer's notebook: A 10 by 8 centrifugal pump rated at 2100 gal. per min. for a total discharge head of 100 ft. at 1575 r.p.m. is installed in a line to pump 45° A.P.I. oil. The suction line consists of 1200 ft. of 10-in. pipe with six 10-in., 90° elbows (medium sweep); the discharge line has 1500 ft. of 8-in. pipe and four 8-in., 90° elbows (medium sweep). There is a 38-ft. gravity head on the suction side of the pump.

In operation the discharge of the line is only 1870 gal. per min., a loss of approximately 12 percent, despite the fact that the number of r.p.m. is constant.

Obviously, there is a loss in the volume of oil being pumped. To determine the exact nature of the losses the figure and table presented are of immediate value.

The speed at which the pump is said to run is neither the full load nor the synchronous speed of an electric motor at any current frequency generally used and we can conclude, therefore, that the pump is either belted or gear-driven. It may safely be assumed that the viscosity of an oil of 45° A.P.I. gravity (0.8017 sp. gr.) is about equal to that of water.

The 38-ft. gravity head specified is on the suction side and is, therefore, to be subtracted from the head loss in the suction line.

By interpolation between the values shown for 2000 and 2200 gal. per min. through 10-in. pipe in Table 1 we find the head loss per 100 ft. to be 3.91 ft. Multiplying 1200 by 3.91 we get 47 ft., which is the total head loss in 1200 ft. of pipe. This loss is only for the

TABLE I

Nominal pipe size, in.

Gal. per min.	Nominal pipe size, in.								
	8			10			12		
	Vel., ft. per sec.	Vel., head in ft.	Head loss, ft. per 100 ft.	Vel., ft. per sec.	Vel., head in ft.	Head loss, ft. per 100 ft.	Vel., ft. per sec.	Vel., head in ft.	Head loss, ft. per 100 ft.
500	3.19	0.16	0.82						
580	3.70	0.21	1.07						
680	4.35	0.29	1.45						
800	5.10	0.40	1.97						
1000	6.38	0.63	2.97	4.08	0.26	1.03			
1100	7.03	0.77	3.52	4.49	0.31	1.19			
1200	7.66	0.91	4.11	4.90	0.37	1.40			
1300	8.30	1.07	4.85	5.31	0.44	1.62			
1400	8.95	1.24	5.50	5.71	0.51	1.87			
1500	9.58	1.42	6.24	6.12	0.58	2.13	4.26	0.28	0.876
1600	10.21	1.62	7.00	6.53	0.66	2.39	4.55	0.32	0.982
1800	11.50	2.05	8.78	7.35	0.84	2.95	5.11	0.40	1.21
2000	12.78	2.53	10.71	8.16	1.02	3.59	5.68	0.50	1.49
2200	14.05	3.06	12.78	8.98	1.25	4.24	6.25	0.60	1.81
2400				9.80	1.50	5.04	6.81	0.72	2.08
2600				10.61	1.75	5.81			
2800				11.41	2.02	6.70	7.95	0.98	2.75
3000				12.24	2.33	7.62			
3200							9.10	1.28	3.51
3500							9.95	1.53	4.16

This table may be used for liquids having a viscosity equal to water. The head loss and the velocity head will read in feet of the liquid, regardless of its specific gravity. As total discharge head of pumps is usually based on water, all power calculations should take into consideration the specific gravity of the liquid.

The table is based on the Williams and Hazen formula, as follows:

$$S = \left(\frac{V}{1.318\ CR^{0.63}}\right)^{1.85}$$

Where

S = friction loss in ft. per ft.
V = velocity in ft. per sec.
C = constant depending on kind and condition of pipe
R = hydraulic radius = $\frac{\text{diameter in ft.}}{4} = \frac{\text{area in sq. ft.}}{\text{perimeter in ft.}}$

A constant of 100 is assumed for ordinary wrought iron pipe without scale or other obstructions.

Tables are from Cameron Hydraulic Data by courtesy of Ingersoll-Rand Company.

A convenient formula devised by the writer for arriving at velocity in ft. per sec. is:

$$V = \frac{\text{g.p.m.} \times 0.0099}{\text{area in sq. in.}}$$

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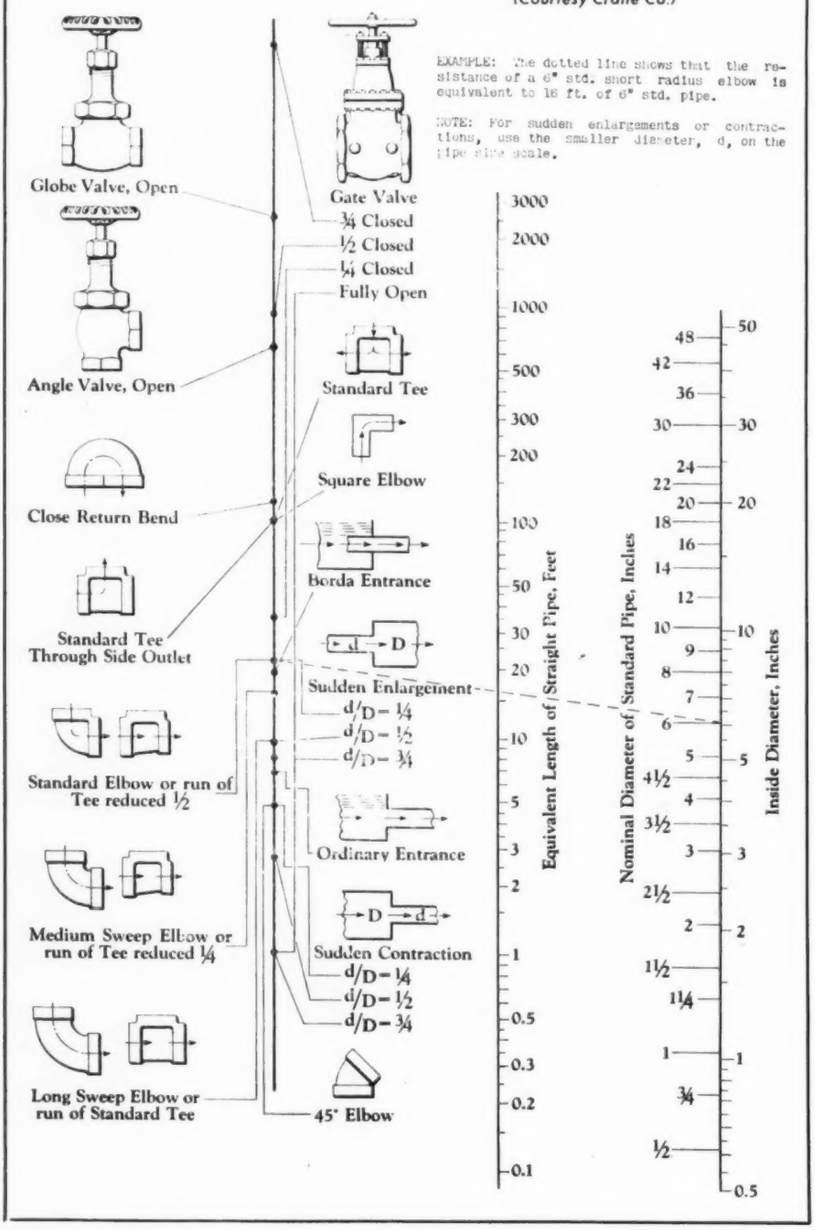
straight pipe in the suction. There are six 10-in. ells each of which represents a head loss equivalent to 23 ft. of straight pipe from Fig. 1, or an additional length of straight pipe of 6 times 23, or 138 ft. Multiplying 1.38 by 3.91 we obtain 5.4 ft. to be added to the figure of 47 ft. for a total head loss in suction of 52.4 ft. The gravity head of 38 ft. subtracted from 52.4 ft. equals 14.4 ft., which is the net head loss due to friction in the suction line. This is about as high a minus suction head as a centrifugal pump should be expected to maintain. If the pumpage is a crude oil or a naphtha, trouble might be expected from vaporizing in the suction under such conditions, and would be reflected in volume capacity of the pump regardless of its discharge head rating. In other words, if 2100 gal. per min. cannot reach the pump in completely liquid phase, the pump cannot deliver that quantity into the discharge line, no matter how low the resistance to flow in the discharge line or how high the potential discharge head of the pump itself.

Now for consideration of discharge conditions: According to Table 1, the head loss in 1500 ft. of 8-in. line will be $15 \times 11.75 = 176$ ft. in the straight pipe and $4 \times 18 = 72$ ft. of pipe for the ells. The head loss in 72 ft. will be $0.72 \times 11.75 = 8.5$ ft., and the total discharge 176 + 8.5, or 184.5 ft.

It is surprising to find from these calculations that the pump delivers within 12.3 percent of its rated volume. In considering this phase of the problem it is to be noted that the head capacity of the pump is not governed by the specific gravity of the pumpage.

Fig. 1. Resistance of valves and fittings to flow of fluids
(Courtesy Crane Co.)



Corrective Measures

Obviously, local conditions must dictate the method to be used to bring about a satisfactory solution to this problem. To replace a section of the suction line with a larger line would correct the suction condition; or perhaps it would be more practicable to loop-in another line to reduce the head loss. In either case Fig. 1 and Table 1 will be of assistance in obtaining the answer. If the looping of the line is being considered, be sure to consider areas, not diameters. Add areas until the desired head loss has been met, then select the nominal pipe diameter equal to the added area.

For correction of the discharge condition the pump manufacturer should be requested to supply a head-capacity curve of the particular pump. From this curve and from the manufacturer's advice a determination can be made of the practicability of increasing the total discharge head by using a larger runner. The same effect can also be had by changing sizes of either or both the driver and driven gear or pulley, assuming, as already stated, that the pump is power-driven. All details of the simple methods of making the necessary calculations will be found in the various articles[1,2] on centrifugal pumps and similar subjects by the writer. Reference is also made to an additional table with some new data on friction loss in oil pipe lines to be found in the Continuous Tables on Page 159 of the October number of *The Petroleum Engineer*.

Power also enters into the calculations when the changes suggested are being considered. The power will be 80 percent of that developed by use of the standard formula, as the formula factor of head in ft. is based upon pumping water, whereas the liquid here considered is 0.80 sp. gr.

The standard formula for power is:

$$\text{hp.} = \frac{\text{Head, ft. of water} \times \text{g.p.m.}}{3960 \times \text{pump efficiency, percent}}$$

[1] "Basic Considerations of Refinery Pumping" by R. G. Lovell, *The Petroleum Engineer*, June, 1942.

[2] "Adaptation of the Centrifugal Pump to Refinery Use" by R. G. Lovell, *The Petroleum Engineer*, Annual Number (July 1), 1942.

☆ ☆ ☆

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PROCESS ENGINEERS AND CONSTRUCTORS FOR THE PETRO-CHEMICAL INDUSTRIES

Electrical Logging to Determine Character of Formations

A discussion of fundamental principles involved, conditions that influence results obtained, equipment employed, type of records and their interpretation and application

by Lester C. Uren

Professor of Petroleum Engineering, University of California

A FEW years ago the rotary driller was dependent upon casual inspection of the drill cuttings brought to the surface with the drilling fluid for his knowledge of the character of the formation penetrated by the bit. He was aided to some extent by observation of the mechanical reactions of the drilling equipment. And the cable-tool driller had little more than bailer and bit samples and mechanical reaction of the tools to help him in the assembling of well log data. Due to deflection of wells, depth measurements were not dependable. Contamination of formation samples with cavings from overlying strata, complete disintegration of drill cuttings in the process of drilling and time lag in bringing the sample to the surface, often left the driller uncertain of the exact nature of the material exposed in the bottom of the well. Drillers' logs of the earlier period were notoriously undependable and there were numerous instances of defective water shut-offs, erratic correlations, oil and gas sands cased off, and wells abandoned as failures in prolific producing areas that could be traced directly to inaccurate well logs.

With the development of petroleum engineering as an applied science, it became imperative that means of obtaining more complete and more dependable subsurface information be devised. Modern methods of field exploitation demand accurate knowledge of the lithologic character, thickness and depth of each stratum penetrated by the well, in addition to information concerning the nature of the fluids present in each stratum and their pressure and temperature. Even though we may not have immediate need of some of this information, it is coming to be recognized that it is the obligation of those engaged in present-day oil-field development to assemble all subsurface information possible to obtain during the progress of well drilling, in anticipation of its eventual need in future exploitation of the field.

LESTER C. UREN

During the last ten years, many new devices and methods for procuring subsurface data have been developed and made available to the well driller. Except for experimental development, practical application of electrical logging has been confined to this period. Today, this art has reached a high degree of perfection and is now widely employed. More recently, radioactivity logging has been developed and is now finding practical application. Geochemical logging, an outgrowth of soil analysis technique employed in exploration for petroleum, has lately been used to a limited extent. Knowledge of the temperature existing at different depths in the well is helpful in some phases of oil-field exploitation, and temperature logs are no longer unusual. Caliper logging, a recent development, affords information on variation in diameter of the well, knowledge of which is helpful in some aspects of well drilling. A rate-of-penetration log, obtainable through use of a "sclerograph" or rate-of-drilling meter, gives data useful in estimating the character of formations penetrated by the drill and the efficiency of operation of the drilling equipment.

Improved types of core barrels facilitate taking of formation samples by mechanical means and in ways not formerly possible. Development of wire-line core barrels has expedited the taking of cores and has reduced their cost. Side-wall sampling devices provide a new approach to the problem of procuring formation samples in intervals previously drilled. Some are mechanical in nature; one involves use of sample-taking bullets shot from guns. New types of core-barrels permit of cutting and extracting cores under high formation pressure, without loss of contained fluids. Magnetic orientation of cores now affords a dependable means of determining the degree of inclination of dip of strata penetrated by the well. The "Dipmeter", employing methods based on observations of resistivity of strata, is used in determining the dip of formations in place in the wall of the well.

New methods of determining the character of fluids present in each stratum penetrated by the well have been devised. By testing the circulating fluid employed in rotary drilling with the aid of electrical devices, small changes in the concentration of salt water and gas may be made apparent. Several types of electrical devices are available for indicating the point of entry of water into a well. Fluorescence under the influence of ultra-violet light is used as a means of identifying small dispersed particles of crude petroleum in drilling fluid. Formation testers have been improved to the point where they now afford a dependable test of the fluids present in the formation exposed in any interval in the well, as well as the pressure conditions existing and the rate of sustained fluid production possible. Available fluid sampling devices now make it possible to obtain an uncontaminated sample from any depth within the fluid column in a well.

These devices and methods collectively represent a notable advance in well-logging technique: an important contribution by the petroleum engineering profession to the rapidly unfolding

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Reveals

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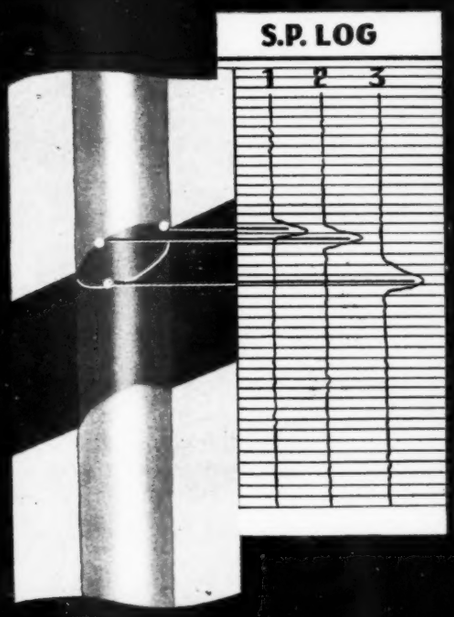
Schlumberger Dipmeter Surveys employ two proven Schlumberger services in combination—electrical well logging and photoclinometer directional surveys. On a single trip in the hole, both direction and magnitude of dip can be accurately determined. The instruments are operated on the standard Schlumberger cable and winch and the survey time is approximately the same as that required for electrical logging.

Complete details will gladly be sent to interested operators on request.

SCHLUMBERGER WELL SURVEYING CORP.
HOUSTON, TEXAS



ORIGINATORS OF

Electrical Well Logging

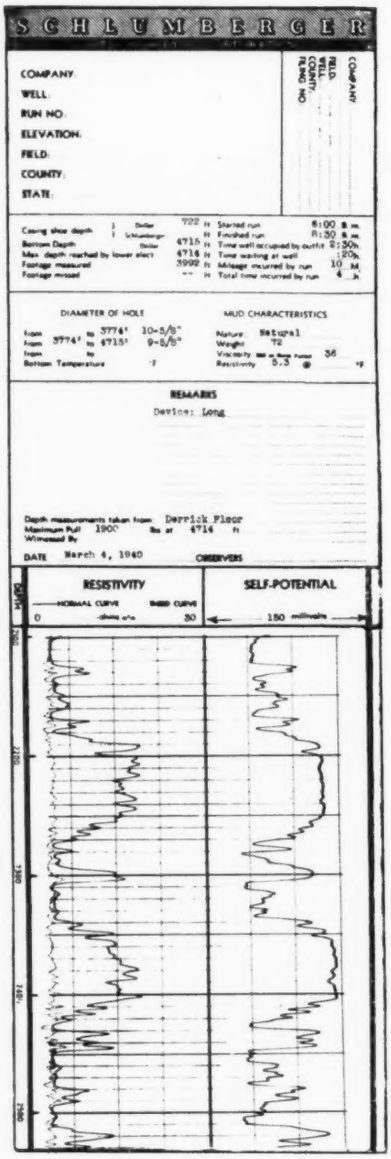
science of oil-field exploitation. Each is a development worthy of separate discussion, but of them all, none is more important or offers more promise for extensive future application than electrical logging. The writer proposes, in the present article, to review the fundamental principles that this method of logging employs, the conditions that influence the results obtained, the equipment employed, type of records procured and their interpretation and application in oil-field exploitation.

First developed and applied by Conrad Schlumberger, a French geophysicist, and his co-workers in the oil-fields of Russia, Venezuela, and Roumania[19] in 1929 - 31, the electrical logging method was introduced into the oil-fields of the United States in 1932, and has since been widely employed in most of the oil-producing regions of this country.[5, 6, 7, 25] Introduction of electrical logging brought to the petroleum industry an entirely new approach to the problem of identifying the character of formations penetrated in the course of drilling. Previously, dependence had been placed on formation samples brought to the surface for inspection. Electrical logging offered a means of determining the character of the formation from observations made in the well, without incurring the delays and expense incidental to mechanical coring or other means of obtaining formation samples. In this sense, development of electrical logging was one of those revolutionary changes that come from time to time to alter the habits and outlook of the industry. It initiated a series of developments of far-reaching importance in the science of petroleum engineering. It was for this reason that the American Institute of Mining and Metallurgical Engineers, in 1941, conferred on Conrad and Marcel Schlumberger, discoverers of the electrical logging method, the Anthony F. Lucas medal "for distinguished achievement in improving the technique and practice of finding and producing petroleum."

Though electrical logging has been used commercially in the American petroleum industry for but a single decade, an extensive literature concerning it has already been accumulated. For the reader who may wish to pursue the subject further, frequent references are given to the better sources of information listed in the selected bibliography printed herewith.

Electrical Logging

Most rock-forming minerals are poor conductors of electricity, but sedimentary formations usually contain water in their pore spaces—frequently saline water—which renders them conductive



(Courtesy Schlumberger Well Surveying Corp.)

Fig. 1. Typical electrical log

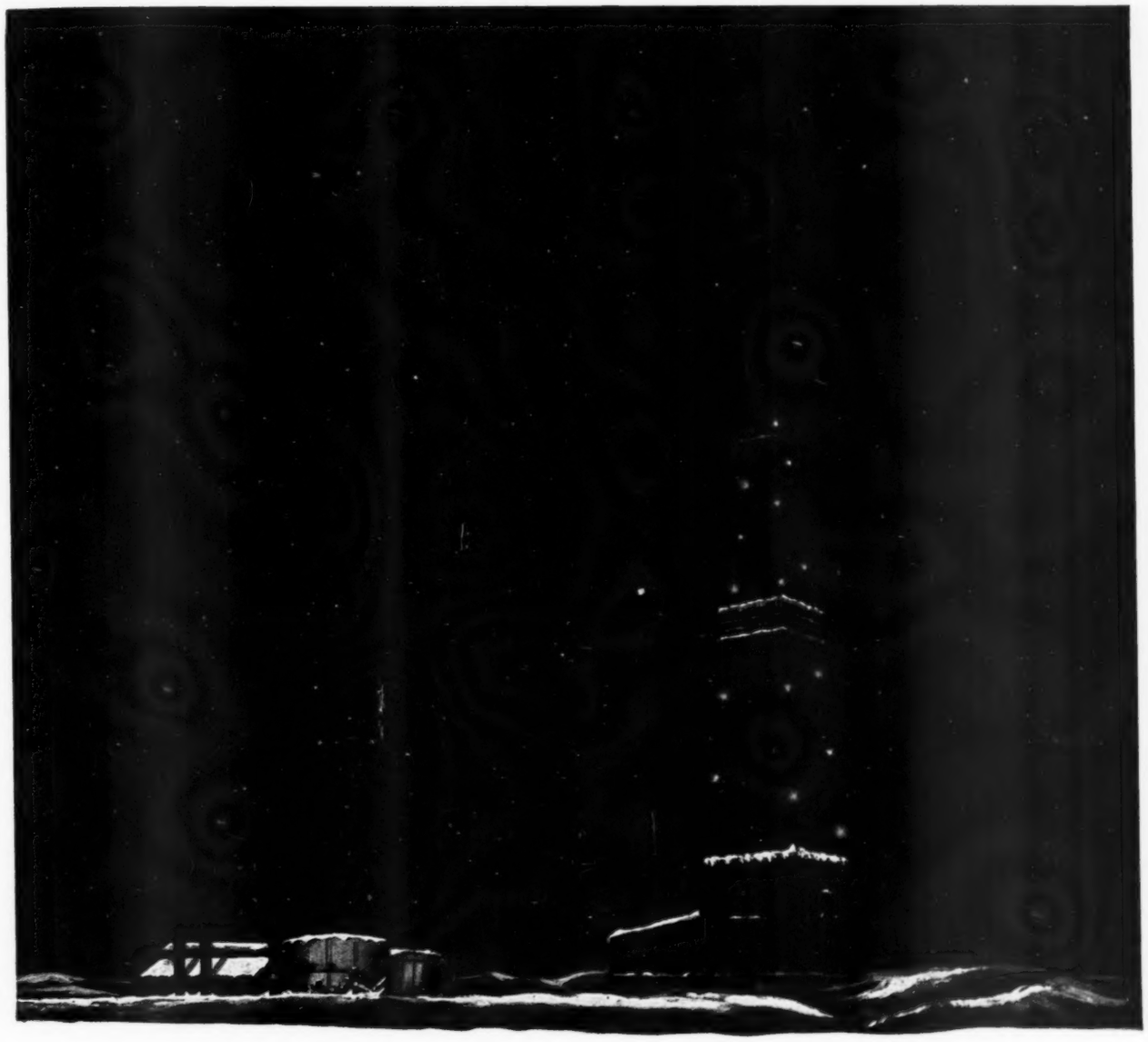
for electricity in varying degree. The greater the amount of moisture and the greater the amount of dissolved electrolytes in the water, the greater the conductivity of the containing rock masses.[27]

Resistivity Measurements. In comparing the electrical properties of rock strata exposed in the wall of a well, a system of electrodes, lowered into the well from the surface on a multi-conductor cable, is employed as a means of establishing a flow of electricity into each stratum, whereas the relative conductivities of different beds are determined by measuring the inverse values of their relative resistivities.[16, 17, 20, 21, 22, 23] The electrode system usually comprises three electrodes suspended at different depths, a few feet apart. One electrode is used as a means of passing direct current through the intervening well fluid into the surrounding strata. The other two electrodes, connected through a potentiometer at the surface, record a certain difference in potential, which, considered in relationship to the spacing of the electrodes, the temperature, and the conductivity of the well fluid, indicates the resistivity of the formation immediately surrounding the input electrode.[29]

The electrode system is slowly lowered into the well and a continuous record showing variation in resistivity as indicated on the potentiometer, is automatically recorded on photographic film in the form of a profile on a depth scale that can be directly compared with a drillers' graphic log of the well. Values of resistivity are expressed in ohms per cu. m. of rock mass, and range from as little as one to several thousand ohms, depending upon the electrical conductivity of the material.

A variety of factors influence the magnitude of the resistivity recorded. If a rock stratum is very compact and contains little moisture, or if the water that is present contains but little dissolved salt, the indicated resistivity will be high. Dense masses of hard rocks like granite, quartzite, gneiss, marble, etc., and softer rocks containing but little connate water, such as gypsum, rock salt, coal, etc., customarily have high resistivities. Unconsolidated and semi-consolidated formations consisting of clays, shales, marls, sands, sandstones, etc., generally contain much water in their interstices—often saline water—and therefore normally possess low resistivities. On the other hand, if non-conductive oil or gas are present instead of saline water, the observed resistivity will be high. In such rocks, the observed resistivity may thus characterize the nature of the fluid confined in the pore spaces of the rock, as well as the lithologic properties.[4]

Inasmuch as the electric current must flow through the well fluid to reach the wall rocks or the electrodes, it is clear that the conductivity of the fluid in the well will greatly influence the observed resistivity.[3, 24] If the well fluid is salty, it will be more conductive and the resistivity will be lower than when the current must flow through fresh water. The spacing between the electrodes determines the depth of investigation, which, in practical work, varies from 3 to 10 ft. If drilling fluid has penetrated the walls of the well for several feet, as may be the case in drilling through permeable beds, close spacing of the electrodes may show quite a different resistivity profile than when the electrodes are widely spaced. The



USUALLY a season devoted to joy and happiness, this Christmas finds us absorbed in the grim business of war. Directly or indirectly, every home in the land has felt its touch . . . and will undoubtedly feel it more severely before we again have "Peace on Earth . . ."

As we look back on happier years, we realize that the fruits of our freedom—peace, liberty, and the pursuit of happiness—are the most valuable possessions of life . . . worth all the fighting, working, and sacrificing necessary to preserve them.

And so, while there's a war to be won—our way of life to be preserved—we say, "Let's make this the best Christmas possible and all 'pull together' toward the brighter, happier ones that are sure to come."

HUGHES TOOL CO. **HOUSTON, TEXAS**

Quarterly Operational Reports Required of Refiners

Seeking information by which to measure the impact of governmental requirements and war emergencies upon the crude oil refining industry, OPA has ordered quarterly operational reports from all refiners of crude petroleum.

The order, issued under the emergency price control act, requires specific data on the nature, capacity, yield, and profitableness of plant operations. OPA report form SSO-55 has been sent by registered mail to all refineries affected. Reports are to cover quarterly periods beginning January 1, 1941, through Sept. 30, 1942, and are returnable on specified dates.

With such records of normal refinery operations available, OPA will be able to expedite decisions on proposed changes in price structure. It will also be able to gauge without delay the immediate effect of proposed or actual demands arising from the impact of war emergencies and future governmental regulations and requirements.

The report forms follow closely the standards of the U. S. Bureau of Mines regarding type of plant, equipment, capacity, and other operations. Also to be included are production costs and total finished production values of the plant.

extent to which drilling fluid penetrates the walls of the well will depend upon the differential pressure between the fluid in the well and that in the formation. Ordinarily this differential pressure increases with depth, so that resistivity measurements taken at shallow depths are not quantitatively comparable with observations at greater depths. Increase in temperature reduces the resistivity and, as earth temperature increases with depth, it follows that the observed values of resistivity in comparable materials become smaller as depth below the earth's surface increases.

Spontaneous electrical phenomena in wells. If a single electrode, suspended on an insulated conductor cable, is lowered into a well, and the other end of the conductor is grounded at the surface, a potentiometer connected in the circuit will show a measurable potential, which is found to vary with the permeability of the formation surrounding the electrode in the well. No electricity from any extraneous source is imposed. This so-called "self-potential" may range as high as 300 mv. The spontaneous electro-motive force thus observed is believed to develop as a result of two simultaneously operative phenomena called "electro-filtration" and "electro-osmosis."[16, 17, 20, 21, 22, 23]

When a liquid is forced through a porous solid medium, a difference in potential between two points in the porous solid is observed. Thus, drilling fluid filtering through the porous rock strata exposed in the wall of a well, develops an electro-filtration effect that creates an electro-motive force that may be measured by the single-electrode circuit described. Also, an electro-motive force is generated whenever two different electrolytes come into contact in water solution in a porous medium: as when drilling fluid enters a permeable stratum from the well and develops contact with the native fluid in the formation. The electro-motive force developed increases as the interfacial surface of the fluids in contact increases, and inasmuch as this interfacial surface of contact increases with the depth of penetration of the drilling fluid into the formation, it follows that a greater electro-osmosis effect is developed in highly permeable strata than in those less so. Electro-filtration e.m.f. and electro-osmosis e.m.f. both result from migration of drilling fluid into the wall rocks, and, as migration occurs more readily and to a greater degree in highly permeable strata than in those less so, it follows that the observed values of the self-potential generated become a measure of the relative permeabilities of the formations that give rise to them.

In recording the self-potential diagram of formations intersected by a well, one of the electrodes in the multi-electrode system employed in making resistivity measurements, is so connected with recording instruments at the surface that as the electrode system traverses the well, a continuous graph is automatically recorded against a depth scale on photographic film. This profile shows relative values of the e.m.f. generated, expressed in mv., opposite each stratum in the interval surveyed. The self-potential diagram was originally called a "porosity log", in the belief that the observed anomalies were proportional to formation porosity, but the e.m.f. generated is primarily responsive to variations in permeability, and such a profile is more properly called a "permeability log".

Most of the factors that influence the magniture of resistivity measurements also influence self-potential measurements. The salinity of the fluid in the well, in comparison with that in the formation; the differential pressure between the well and the formation, and the temperature, all have their effect. In addition, the viscosity of the well fluid will influence the rate of penetration of the wall rocks and hence influences the observed potential, the two factors being inversely proportional. The density of the drilling fluid influences the differential pressure between the well and the formation and thus high fluid density tends to increase the observed e.m.f. Self-potential values normally increase with depth, due to the greater excess of pressure of the well fluid over that of the formational fluids with increasing depth. Temperature increases with depth and increases the fluid conductivity, hence the observed values of the self-potential generated normally decrease with depth.

Equipment employed in electrical logging. Successful electrical logging requires specially designed equipment and skilled technical personnel. The methods and apparatus used are patented and licensed for use only to certain service organizations that make a business of conducting electrical surveys of wells on a fee basis. One service organization sends the equipment into the field on two motor trucks.[15] A heavy motor truck equipped with a winch carries the multi-conductor cable, which, in outfits designed for deep wells, may be as much as 15,000-ft. in length. A second "panel truck" carries the electrical and mechanical recording equipment and photographic apparatus. A direct-current generator, with controls that permit a wide range of voltage, provides current down through the cable to the imput electrode. Alternating current may also be used.[11] After traversing the formations about the well, the electrical impulses are picked up by the receiving electrodes, transmitted back to the surface through the multi-conductor cable, and their amplitude measured by three meters. Variations in readings on these meters correspond to variations in electrical characteristics of the formations tested. A beam of light is reflected from a mirror mounted on the indicating element of each of the three meters, and these light beams are so directed as to record each minute variation in amplitude of the meter indicators on a moving strip of sensitized film. Three profiles are thus recorded simultaneously on the same strip of film as the electrode system traverses the well: two resistiv-

WE MUST GET MORE SCRAP INTO THIS FIGHT!

The Need Is Urgent—VITALLY Urgent—If We Hope to Win This War...and Here's Why...

The average person has little conception of the monstrous amounts of steel our war effort is consuming . . . steel for ships, steel for tanks, steel for guns, steel for shells and bombs . . . *and steel to build the giant machines and factories where the ships and tanks and guns are made!*

We are trying to overcome in one year the stupendous quantities of war equipment Germany and Japan have been amassing for *ten* years. They have said we can't do it—*and they are mighty close to being right!*

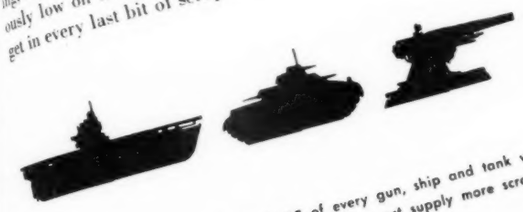
For today our war effort is threatening to slow down through lack of steel. Steel mills are working harder than they ever have before, but they are scraping the bottom of the barrel on scrap supplies.

And they MUST have scrap. By the very nature of the steel refining process, one-third to one-half of every open hearth charge must be steel scrap for efficient refining. So even the largest stockpiles of limestone, coal and ore are virtually useless *unless we can supply the scrap to go with them.*

It's up to every one of us—executives, field men, engineers, roustabouts—*all* of us to get more scrap into this fight. Look at every piece of equipment around you with the thought *"Can we possibly do without this?"* Check *and re-check* every corner of your rigs, your leases, your pumping plants, your refineries, to turn up every last piece of metal you can get along without. Make it a standing rule . . .

If it hasn't been used for three months, and someone can't prove that it's going to be used in the next three months —find a use for it—or SCRAP IT!

WHY THIS NATION DESPERATELY NEEDS SCRAP! Scrap is an essential part of the open hearth steel process—the backbone of our steel industry. Each ton of scrap replaces *three and one-quarter* tons of limestone, coal and ore—saves three times the handling, three times the mining, and makes steel *faster*. Already our steel industry is getting dangerously low on its scrap supplies. So to keep our steel flowing, we must get in every last bit of scrap metal we can lay our hands on!

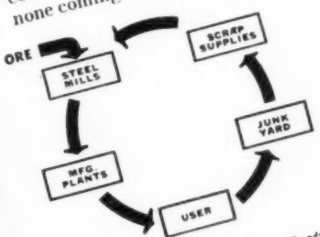


SCRAP FORMS ABOUT ONE-HALF of every gun, ship and tank we build. To build more fighting equipment, we must supply more scrap!

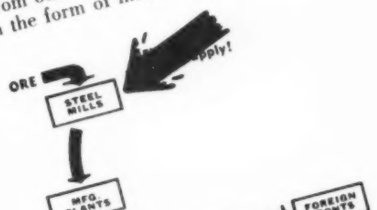
WHAT'S HAPPENING TO OUR SCRAP SUPPLIES? For one thing, it's being used up faster than ever before in the history of the nation, because we're making steel faster than ever before.

Then, because new machines and equipment are becoming scarcer, people and industries are making their old equipment last longer. That means less and less scrap going to the junk yards than before.

Finally, the steel we are now making is taking a *one way* trip to foreign fronts instead of being used up within the country. And as long as we can keep the war *away* from our shores, the steel will continue to go *out* of the country in the form of munitions, with none coming back . . .



IN NORMAL TIMES new machinery and equipment being produced replace worn out equipment, which is junked and goes back as scrap to make steel for new equipment again. This cycle maintains the scrap supply at normal requirements.



IN WAR TIMES the guns, tanks, ships we build are lost in the bottom of the ocean or used up on foreign soil. That means our price for keeping the war from our shores is a constant search for new scrap material to replace that lost!

IT TAKES NO MENTAL GIANT to see that these facts all add up to one thing. Our scrap shortage is no "phoney." It is the most serious emergency confronting our nation today. It is up to all of us to see that everything that looks like metal, feels like metal, works like metal, is turned into scrap RIGHT NOW if it can possibly be spared.

Give someone on each of your leases, your refineries, your storage yards authority to decide what can be scrapped. Have him appoint a Salvage Committee in his area to survey—*and re-survey*—every last corner for idle equipment that can be scrapped . . . for pipe, sheet iron, cable, drums—*anything* that has scrap value. *Get it in NOW. The need was never more urgent!*

BAASH ROSS TOOL CO.

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

PETROLEUM ENGINEER EDITION

A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

ity profiles and the self-potential profile. The apparatus permits of constant observation of the recording process by the operator. Movement of the sensitized film past the light beams is synchronized by a gear mechanism with the vertical movement of the cable in the well. Either of three depth scales may be used: 1 in. to 20 ft., 1 in. to 50 ft., or 1 in. to 100 ft. Another mechanism prints on the moving film, the reference coördinates, scales, and depth figures. The electrode system traverses the well at a rate of from 100 to 150 ft. per min. and a continuous record is procured over the interval surveyed. The panel truck is equipped with photographic developing and fixing tanks, so that the primary record can be completed and examined at the well. Later, prints are made on sensitized paper from the primary film record. The film record may be obtained in from one to three hours at the well.

Character of records obtained in electrical logging. Fig. 1 is illustrative of the type of electrical log usually supplied by service organizations doing this type of work. On a depth scale of 1 in. to 50 ft., the record strip is about 7 in. wide and of whatever length may be necessary to display the interval logged on the scale employed. The upper part of the record gives all necessary identifying data and such other information as is necessary for proper interpretation of the logs. The left side of the record displays two separate resistivity logs (one a solid line and the other dotted), and the right side gives the "porosity log" or "self-potential" or "natural potential" profile. The resistivity log that appears as a dotted profile, is one made with wider spacing of the electrodes and represents a record of greater lateral depth investigation than the solid-line resistivity profile. The latter is believed to represent a penetration of about 3 ft., whereas the so-called "second curve" probably represents a depth of investigation of about 6 ft. If necessary, a third resistivity profile representing a depth of investigation of about 10 ft. may be added to the record. These additional resistivity profiles are helpful in cases where drilling fluid has invaded the wall rocks to a depth of several feet and the normal spacing of electrodes does not differentiate satisfactorily between the various strata comprising the interval surveyed.

Interpretation of electrical logs. From the foregoing discussion of the theoretical aspects of electrical logging, it will be evident that electrical logs represent the composite effect of many different complex variables and that a complete interpretation of the record would require careful consideration of the influence of each of these factors and of the fundamental nature of the process by which the record is obtained.[2, 10] Complete interpretation of the record should be entrusted to engineers skilled in this work, yet certain elementary characteristics of these logs are so apparent that even the novice may profit by inspection of them.[26]

With the knowledge that variations in resistivity are responsive primarily to the fluid content of rock strata and that variations in self-potential voltage are responsive primarily to changes in the permeability of strata, we may, by observing the character of these two parameters, make broad conclusions concerning the lithologic character of the strata, their thickness and fluid content. A high resistivity value is usually indicative of the presence of oil, gas, fresh water, or sulphur water at the horizon logged; a low resistivity value ordinarily means salt water. A high voltage on the self-potential profile is characteristic of a highly permeable stratum; a low voltage is indicative of an impermeable material. If there are marked changes in the character of strata as between say, an oil sand and the underlying and overlying shales, it is often possible to determine with considerable accuracy, the thickness of the productive stratum and also that portion of it that contains and will yield the most oil.

If we are seeking commercially productive oil and gas sands, we should be interested in any stratum of reasonable thickness that on an electrical log develops a high resistivity value and a high self-potential value, these indications being characteristic of permeable strata containing oil or gas. It must be emphasized, however, that these characteristics may be influenced by many other factors and that the indications mentioned, although usually dependable, are not an infallible guide. Detailed study of the profiles by a per-

Sale of Heretofore Frozen Inventory Stocks Permitted

Sale of heretofore frozen inventory stocks in the oil industry is now permitted by War Production Board Preference Rating Order P-98-C, issued upon recommendation of the Office of Petroleum Coördinator for War.

The new order permits the sale of inventory stocks by one oil operator to another oil operator.

Petroleum Coördinator for War Harold L. Ickes said that a net saving in the petroleum industry's materials requirements can be expected as a result of the new order, because the distribution of idle stocks to productive uses should result in a corresponding decrease in the industry's requirements for new materials.

The new order removes the petroleum industry from certain restrictions of Priorities Regulation No. 13, under which certain stocks of materials are frozen and cannot be sold either within or outside an industry except by approval of the War Production Board or according to the terms of the regulation.

The following provisions are embodied in P-98-C.

A petroleum industry operator can sell to another petroleum industry operator any material he has in stock without obtaining prior permission from the War Production Board.

An oil operator can sell materials to an oil industry supplier only in accordance with provisions in Priorities Regulation No. 13.

An oil industry operator can sell materials to an operator in another industry only in accordance with the provisions of Priorities Regulation No. 13.

The new order does not authorize the receipt or use of materials in violation of any inventory, quota, or use restrictions imposed by any order or regulation.

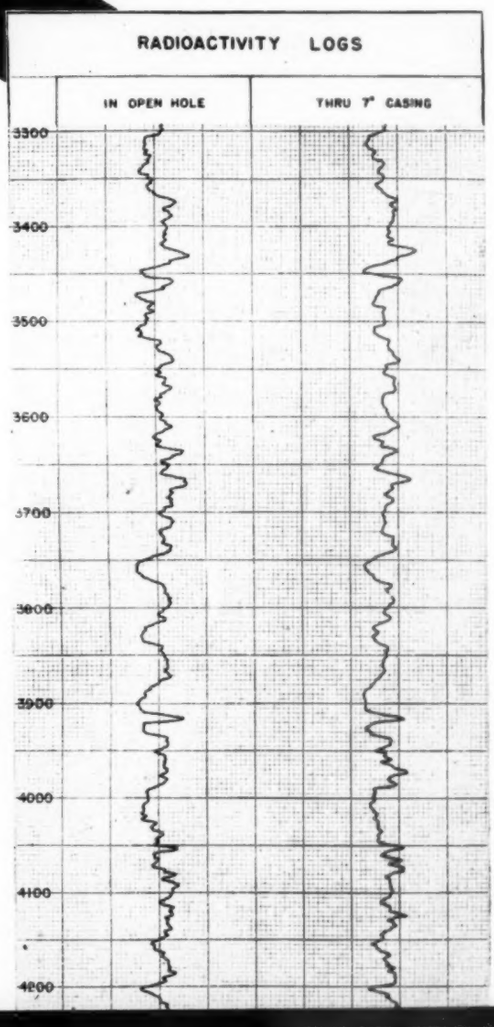
"By using stocks already in inventory," Deputy Coördinator Ralph K. Davies said, "the oil industry will be taking advantage of materials already in stock and will, as a result, reduce the number of requests for priority assistance to obtain materials that have recently been or are yet to be manufactured."

The Deputy Coördinator explained that control over the distribution and use of materials in the oil industry will continue to be exercised through War Production Board Orders P-98-B and M-68, both of which are still in force.

All reports required to be filed and all communications concerning P-98-C, should be addressed to "Office of Petroleum Coördinator for War, South Interior Building, Washington, D. C., Ref. — P-98-C," or "Office of Oil Controller, Dominion of Canada, Toronto, Canada, Ref.—P-98-C."

TO CORRECT DEPTH DETERMINATIONS AND PRODUCE ACCURATE RECORDS THROUGH CASING

RUN A Radioactivity LOG



Radioactivity Well Logging provides accurate information about formation back of casing in wells where sample logs were made without proper consideration for "sample lag."

Accurate Radioactivity Logs can be made regardless of the nature of the well fluid.

In wells drilled prior to electrical logging, potential producing zones can be located for secondary production.

This information is vital if operators are to meet production demands with a reasonable measure of efficiency and continue to operate economically.

Information about Radioactivity Well Logging and its application to your producing problems is available through any Lane-Wells Branch. Call your Lane-Wells Field Office and ask about it.

Tomorrow's Tools-Today!

LANE-WELLS

TECHNICAL OIL FIELD SERVICES

WHEREVER MEN DRILL FOR OIL

General Offices and Export Office • 5610 South Soto Street • Los Angeles

son skilled in their interpretation and familiar with the region in which the well is situated and with all the circumstances surrounding the survey, may be neccessary for an intelligent appraisal of the result. For example, a sand or sand-stone that is free of clay, silt, volcanic ash, and other fine-textured materials should be highly resistive if it contains oil or gas in its pore spaces. An oil-bearing shaly sand on the other hand, is likely to contain considerable connate water, usually salt water, and though oil may be present in abundance and the indicated permeability may be high, yet the presence of conductive salt water may prevent the resistivity profile from attaining the form generally regarded as characteristic of commercially productive oil sands. Fine-grained oil sands generally contain more connate water than coarse sands and hence are less resistive. A gas-bearing stratum should contain less connate water than an oil-bearing stratum, and hence should display higher resistivity. On the other hand, gas-bearing sands are more readily invaded by drilling fluid than oil sands, and if the drilling fluid contains dissolved salts, gas sands may appear less resistive than oil sands. A resistivity profile of greater depth penetration should be helpful in disclosing this condition. Distinction between oil and gas sands is usually difficult unless a temperature survey is combined with the electrical survey. If gas is present in a stratum penetrated by a well and is allowed to flow into the well sufficiently to permit local gas expansion at the wall of the well, the temperature survey will disclose a lower-than-normal temperature where the well penetrates the gas-bearing stratum. Beds of solid salt, limestone or well cemented sand-stone often develop high resistivity because, being dense and non-porous, they contain little or no connate water. They would not ordinarily be confused with oil or gas sands, however, because their indicated permeability on the self-potential profile would be low.

Applications of electrical logs. As suggested in the foregoing paragraph, one of the most important applications of electrical logs is that of indicating the lithologic character, thickness, and fluid content of strata penetrated by the well, thus affording a means of identifying all oil-, gas-, and water-bearing sands and of estimating the possibility of obtaining commercial production from them.[1] Ability to classify strata penetrated by the wells in a field as oil sands, gas sands, water sands, or shale bodies, and to indicate their relative productive capacities, is of great value to one planning the casing and completion program of a well in process of drilling. On the basis of such information, arrangements may be made to cement off all water-yielding beds behind blank casing and to perforate the oil string opposite potential oil- and gas-producing strata. In some fields where the oil-producing strata must be "shot" with explosives to stimulate production, electrical logs have been helpful in determining the exact depths at which to place the explosive. If, for any reason, it should be desired to case off certain potential producing horizons when a well is first completed and placed on production, the electrical logs will show at any future time when it may be desired to produce from them, just where the casing must be perforated to reopen such excluded oil or gas sands. In many cases, electrical logs have disclosed the presence of minor oil sands that were not made known by any other indication in the routine of drilling and testing.

Another very important application of electrical logs is their use in correlation of strata from well to well, and in the use of such correlations in interpreting geologic structure.[14, 18] A certain sequence of strata will often develop a peculiar pattern in the resistivity and self-potential profiles that is characteristic of that particular interval. Usually such patterns can be recognized in the logs of different wells in the same locality, so that by reference to them, correlations of formations from well to well may be made with confidence. Often some particular stratum exhibits an abnormally high resistivity or self-potential value that will serve to identify it in the section. In fields where electrical logs have been made in many wells, certain electrical "markers" are recognizable in almost every log and come to be known by particular name, letter, or number designations.

Electrical markers have proved to be the most dependable basis for correlation in many localities. In thick formations containing many individual reservoir sands, it is helpful in tracing the continuity of beds to have reference markers that can be identified within the oil-producing zone. In the thick producing formations of certain California fields, for example, aggregating perhaps many hundreds of feet in thickness and composed of closely interstratified beds of sand and shale, some strata are more prolific producers than others, and it is important to have a means of recognizing these in drilling the wells, in order that perforated pipe may be set properly and in order that a systematic plan of drainage may be carried out. Often water-yielding strata are so intimately related to the oil- and gas-bearing sands that very precise information of their depths and thicknesses must be had before they properly can be sealed off. For such purposes, a dependable basis for correlation and identification of particular strata or groups in each well drilled, will be of great value.

Ability to correlate formations from well to well with certainty, greatly facilitates interpretation of geologic structure: a problem of importance in the early development of every field. Location of faults intersecting strata between wells is often clearly disclosed by correlation of well logs. The existence of a fault is indicated by a missing interval in one log that is clearly apparent in the log of another near-by well. Close study of a series of electrical logs will usually reveal the course of a fault plane across a field, or lenticular conditions that result in variation in thickness of beds in different areas within the field. Detailed and accurate tectonic studies are greatly facilitated in fields where a sufficient number of electrical logs are available.

One of the several methods of estimating the amount of oil in an oil field involves estimating the thickness, porosity, and oil saturation of the producing strata. From such information, we may compute the storage space available in the formation for accumulation of oil and thus arrive at a figure representing the gross amount of oil originally present. Often the actual thickness of the oil-yielding formation is somewhat uncertain, as the drillers' logs do not usually give sufficiently accurate and dependable information.[8] The electrical logs afford data that indicate with fair accuracy, the thickness of the oil-yielding beds and, in a qualitative sense, comparative permeabilities of different portions of the producing formation.[1] The latter factor enters in estimating the probable recovery and rate of recovery. In conjunction with pressure observations, it may also assist the engineer in predicting initial productions of wells.[13]

In the drilling of wells, difficulties occasionally arise that result in detachment or breakage of tools or parting of casings. Often these detached sections of pipe or parts of drilling equipment cannot readily be fished out of the hole and to save time and trouble, are "sidetracked": a procedure that drives them into the walls of the well. Often they are a source of trouble in subsequent drilling or reconditioning operations, perhaps moving down the hole to some extent as drilling proceeds. Usually it is desirable to know their exact position so that they can be recorded properly in the final log of the well. The electrical log shows their exact position, the resistivity log displaying ab-

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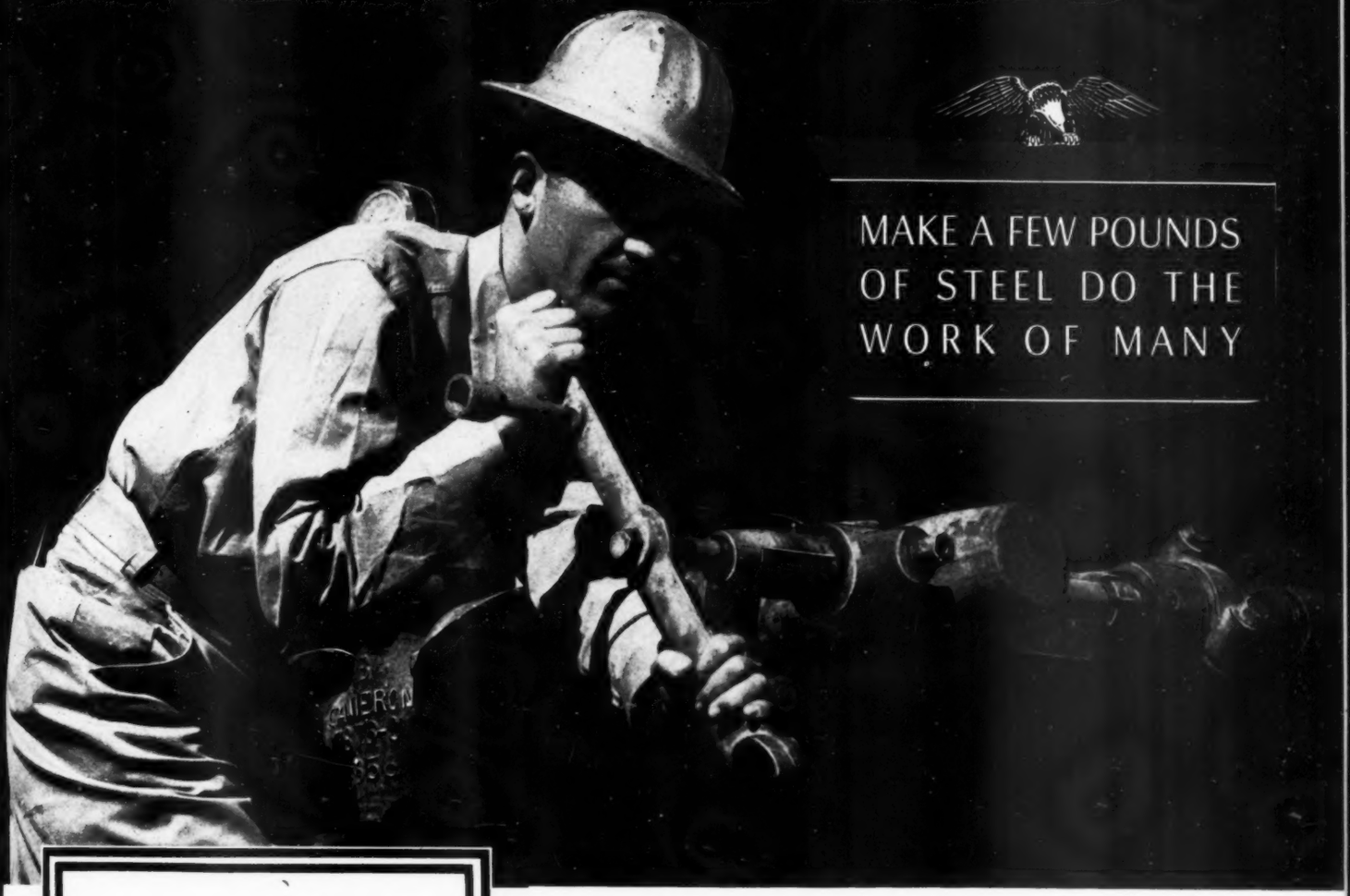

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Cross-section view of a Cameron Type "D" Flow Wing

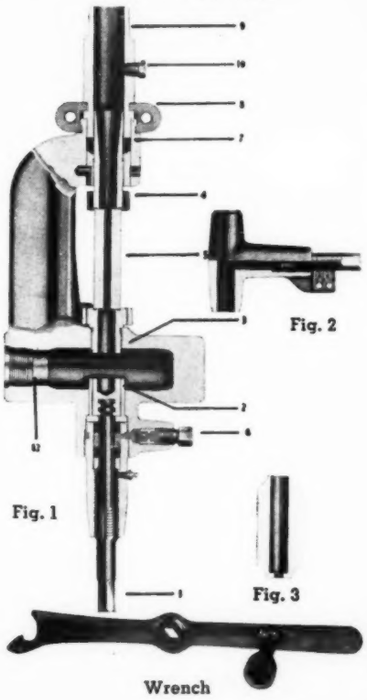

Fig. 1

Fig. 2

Fig. 3

Wrench

In keeping with the spirit of the times, Cameron urges production men to consider Cameron Flow Wings as a safe means for saving critical steel on Xmas tree manifolds. Four essential Xmas tree fittings are combined in this single compact unit: (1) An efficient wing valve that closes easily under full rated pressure; (2) A quick-change positive or adjustable choke, as desired; (3) An efficient 2-bolt flowline union that obviates the need for an additional union in the flowline; and (4) A bleeder plug to release pressure trapped in the flowline.

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Referring to Figure 1 at left, to change flow bean fit hexagon socket in wrench to valve stem (1) and close valve (2) against seat (3). Spanner part of wrench is then applied to clamp screw (4), and only two turns required to release flow bean (5). New bean is clamped in place by clamp screw and valve is then opened and well is back on production. Both valve steam and valve seat are faced with hard metal to resist cutting. Valve stem and bonnet are packed with plastic packing which may be replenished under pressure. Clamp screw is packed with an asbestos ring (7) which is tightened automatically as flow bean is clamped in place. Two-bolt union (8) obviates need for additional union in flow line. Note that downstream end of clamp screw is belled to reduce turbulence and cutting. Three types of flow beans are interchangeable: (1) "Proration" bean illustrated in flow wing; (2) adjustable flow bean, Figure 2; and (3) "production" type bean which consists of a body and renewable stellite orifice disc. All flow beans clamp in position as shown in Figure 1.

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normally low values when near metallic objects.

The exact position of the lower end of a column of casing in a well is sometimes a matter of uncertainty, even though the casing extends to the surface and measurements have been made as it is inserted. Because of crookedness of the hole, the lower end of the column may actually be at some structurally higher point than the length of the column might lead one to expect. The electrical log shows precisely the point at which the apparatus emerges from the casing and enters the open, uncased hole below.

Opportunity for Further Development

The art of electrical logging is young and many opportunities for its further development and application doubtless still exist. Up to the present time, electrical logs have been used primarily in making relative comparisons of rock properties. The data have been regarded as having only qualitative value. Yet, it would seem that the resistivity and self-potential records should have quantitative significance, and that if we had sufficient information or understood them well enough, we could begin to interpret them in terms of actual sand permeability, porosity, oil or water content. Perhaps also, they will find new applications, as in determining the depth of penetration of drilling fluids, the effective thickness of clay wall sheaths, proximity of wells to edge waters, location of unconformities, gas-oil interfaces in gas-cap areas, etc. A new method of obtaining electrical records while drilling is in progress, by making the logging equipment a part of the regular drilling "string", has been proposed and partially developed.[9] Present methods of electrical logging are applicable only in open hole, but some way of procuring resistivity and self-potential records through casing or outside of casing, may yet be developed, using perhaps, more complex circuits in which the casing plays a part—such as that employed by the "Strata-Graph".

Although these and other possibilities for further development of electrical logging exist, it is apparent that we are dealing with a complex system of variables in which there are necessarily some factors that can seldom be evaluated quantitatively.[28] What is the actual path of the electrical current between the input and recording electrodes in the resistivity circuit? How much of it travels exclusively through the well fluid and how much of it actually penetrates the wall rocks, and how far into the wall rocks does it penetrate? What is the effect of drilling fluid conductivity, of thickness and character of clay sheath on the wall of the well, of well diameter, of electrode spacing,[29] and of temperature on the depth of penetration of the current into the formation? To what extent do the thicknesses of strata in the section influence the results, and what is the influence of electrode spacing in this connection? To what extent does salinity of water in the wall rocks influence the magnitude of the risistivity and self-potential records? Does connate water trapped in an oil-bearing stratum influence the resistivity profile?

Those engaged in selling electrical service to the oil industry, as well as engineers and operators engaged in oil-field exploitation, will be interested in finding answers to these and other questions that have a bearing upon the interpretation and utility of electrical logs. Some of these questions can best be answered by laboratory research, some by systematic field observations in wells where the subsurface conditions have been determined accurately by other methods. Comparison of electrical logs with the results of inspection of core samples taken through the same well intervals, will afford an approach to many of these problems.[12]

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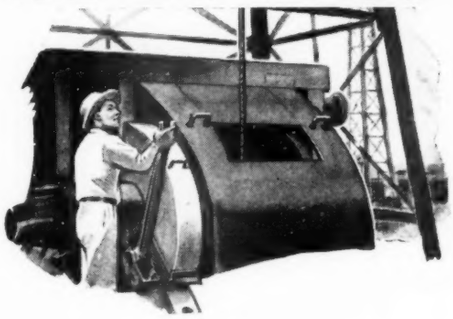

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High-Pressure Gas Measurement*

PART 3 (Concluded)

by Donald L. Katz, T. A. Matthews, and C. H. Roland

TO evaluate the effect of the small deviations of pseudo critical temperatures and pressures from a smooth curve against gas gravity, comparisons of compressibility factors were determined with the pseudo criticals from the smooth curve and from those given by the gas analyses. As the greatest errors are likely due to temperature effects, two conditions were selected for these calculations; 40°F. and 1500 lb. and 140°F. and 1500 lb. The compressibility factors for these two conditions by the two methods are included in Tables 9 and 10.

The errors are retabulated on Table 11 including the averages for all gases having gravities under 0.750. The condition of 40°F. and 1500 lb. is about the worst condition that could be encountered. Although the average error is 2.11 percent for the Grapeland gases, the maximum deviation in temperatures is 7°F. This demonstrates the fact that compressibility factor changes with temperature are more rapid than the proportional absolute temperature change. Inspection of the Grapeland gases on Fig. 5 shows that one curve for the residues and one curve for the plant intakes would have reproduced the pseudo criticals almost perfectly.

Pseudo criticals as a function of gas gravity for 150 natural gases. One hundred and fifty gas analyses were collected from miscellaneous sources including the above. The pseudo critical temperatures and pressures and gas gravities were computed with data similar to Tables 9 and 10. Fig. 7 is a plot of the pseudo critical temperatures and pressures as a function of gas gravity. The only distinction made among the points is the identification of gases containing nitrogen or carbon dioxide in reported quantities, as these gases would not necessarily follow a general curve for hydrocarbon gases. Considerable scattering of the points occurs especially at higher gas gravities.

In order to evaluate the effect of this scattering of points on the compressibility factors, comparisons similar to those of Tables 9 and 10 were made with the results shown in Table 11. The 3.94 percent average error for the 40°F. compressibiilty factors probably includes several gases of high gravity in the two-phase region. The average error of 1.8 percent for the 140°F. factors is relatively low for this general relationship.

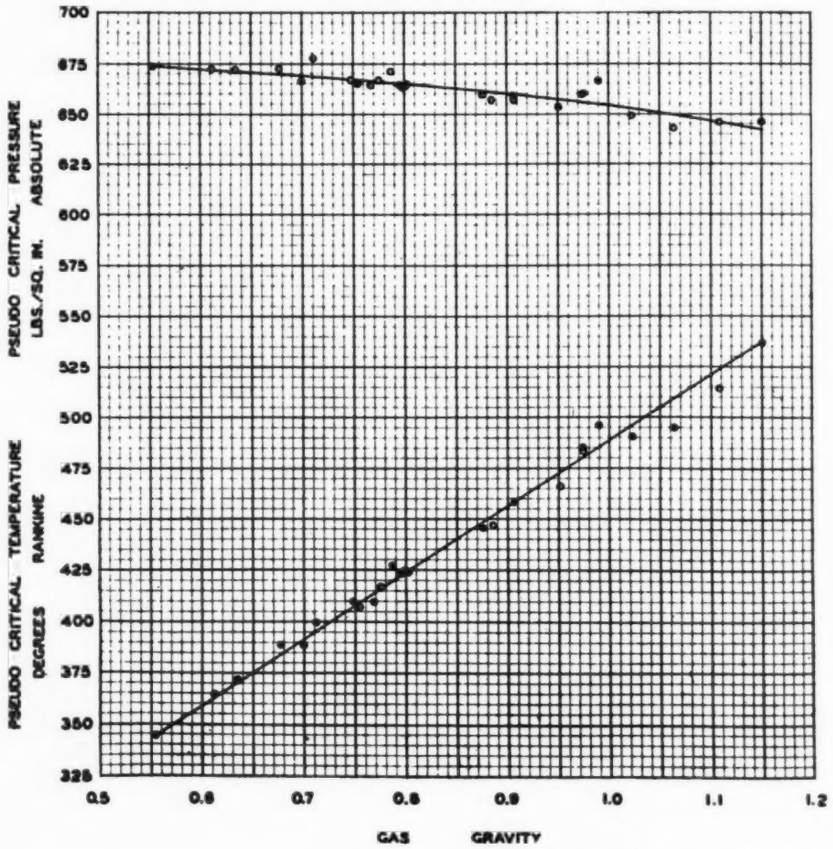
Meter factor charts. Meter factors that correct gas volumes for deviation of gases from ideal may be computed as a function of temperature, pressure, and gas gravity provided the pseudo critical temperature and pressure are a function of gas gravity. The deviation factor alone is the square root of the reciprocal of the compressibility factor and may be computed as shown in Table 12. The deviation factor may be combined with the temperature and gravity factor as previously described.

Fig. 8 is a plot of the deviation-temperature factor, F_{TZ}, for Oklahoma City and Grapeland gases, as they have the same function of pseudo critical conditions with gas gravity. It is necessary to make individual charts for each gas gravity and interpolate between these charts for intermediate gravities. Tables could be set up to give the usual correction factors for any series of gases.

As the gas gravity must be known to find the meter factor, it is just as convenient to include the gravity factor with the temperature and deviation. Fig. 9 gives the three types of meter factors for the Oklahoma City and Grapeland gases. There seems to be little advantage of one over the other from the type of curves involved. Also, it may be shown that ease of interpolation between gas gravities shifts from one type of chart to another depending upon the specific conditions.

Fig. 10 is a plot of the F_{GTZ} factors corresponding to the gas gravity-pseudo critical property curves of Fig. 7 for miscellaneous gases. The sensitivity of the meter factor at low temperature at pressures from 1000 to 2000 lb. is observed again. Also, some of the gases of high gravity may be in the two-phase

Fig. 7. Pseudo physical properties of 150 natural gases



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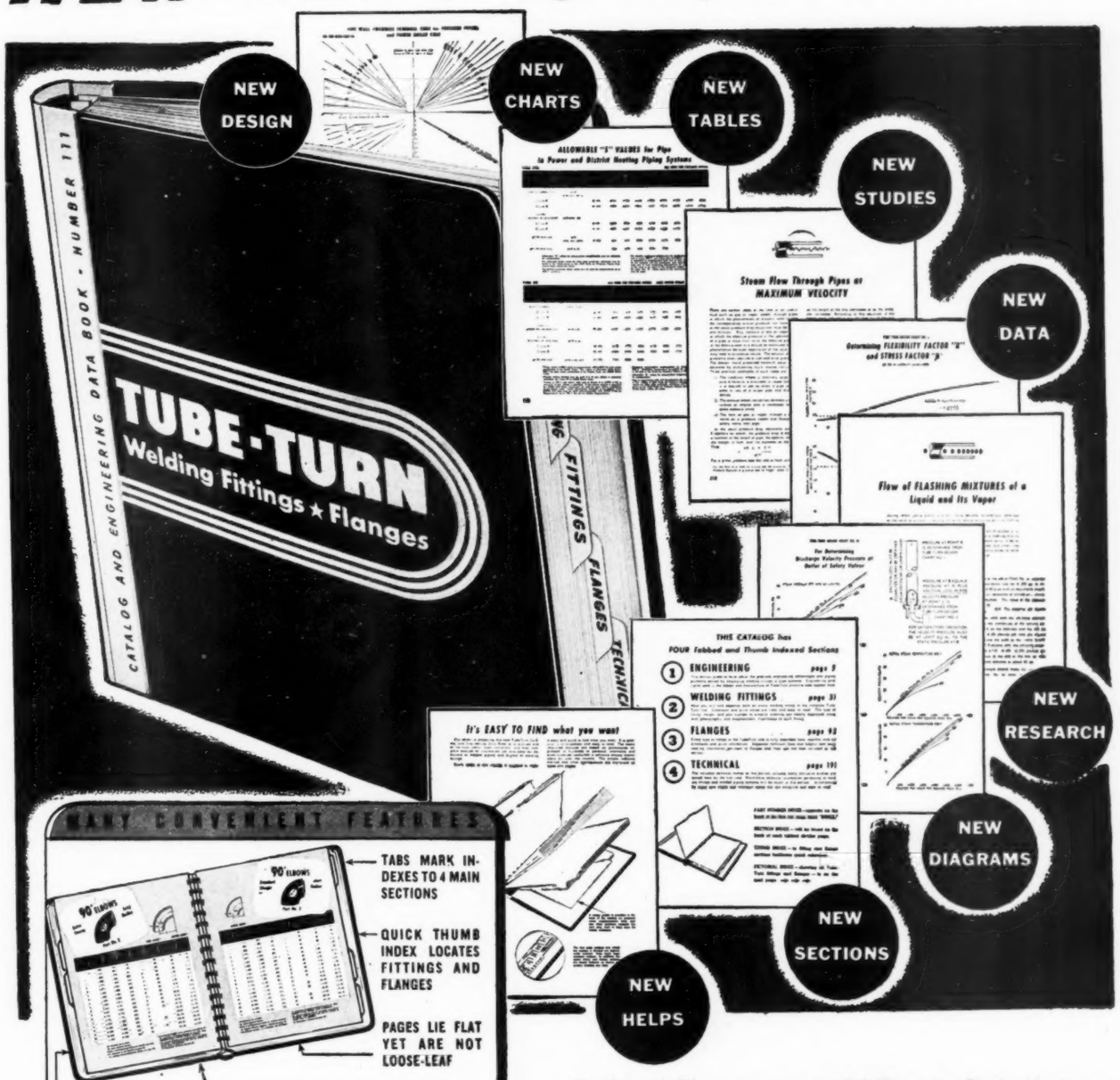
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The errors given for the compressibility factors by Tables 9, 10, and 11 should not be construed as the errors in the meter factors. As the square root of the deviation enters the meter formula, the error in the meter factors are about one-half of those shown. Thus the average errors at 40°F. and 1500 lb. for the Grapeland and Oklahoma City gases due to use of the pseudo critical-gravity curve are 1.1 percent and 1.3 percent, respectively, of the meter factor. The maximum error in meter factor for any of these two groups of gases is 3 percent. For the 139 gases at 40°F. and 1500 lb., the average error in the meter factor becomes 2 percent due to assuming that all gases follow the pseudo critical-gas gravity relationship whereas the maximum error may become as large as 10 percent.

The total error in gas measurement due to density calculations includes the uncertainties in the compressibility factor plot and may increase the above values by 1 percent on the average. It is impossible to make definite statements on probable accuracy without describing the T_R and P_R, etc., under consideration.

TABLE 11

Comparison of compressibility factors from individually computed pseudo criticals with those from curves vs. gas gravity

Comparison at 1500 lb. per sq. in.

No. considered	Gases	Temp., °F.	Algebraic average error, percent	Numerical average error, percent
18	Oklahoma City	40	−0.83	2.63
6	Oklahoma City, less than 0.75 gravity	40	+0.55	1.51
25	Oklahoma City	140	+0.90	2.38
6	Oklahoma City, less than 0.75 gravity	140	+0.16	0.36
17	Grapeland	40	+1.24	2.11
11	Grapeland, less than 0.75 gravity	40	+0.58	1.92
17	Grapeland	140	+0.57	1.05
11	Grapeland, less than 0.75 gravity	140	+0.27	0.88
139	Miscellaneous gases	40	−0.66	3.94
150	Miscellaneous gases	140	−0.12	1.82
77	Miscellaneous gases, less than 0.75 gravity	40	+0.02	1.62
77	Miscellaneous gases, less than 0.75 gravity	140	−0.10	0.62

Gasoline content as an added variable. As stated, the gasoline content would be expected to help characterize the pseudo critical conditions of gases but was found to be little added help to gas gravity when applied to miscellaneous gases. Also, if it were to be used for specific gases, it would be necessary

Fig. 8. Meter factors for Grapeland and Oklahoma City gases

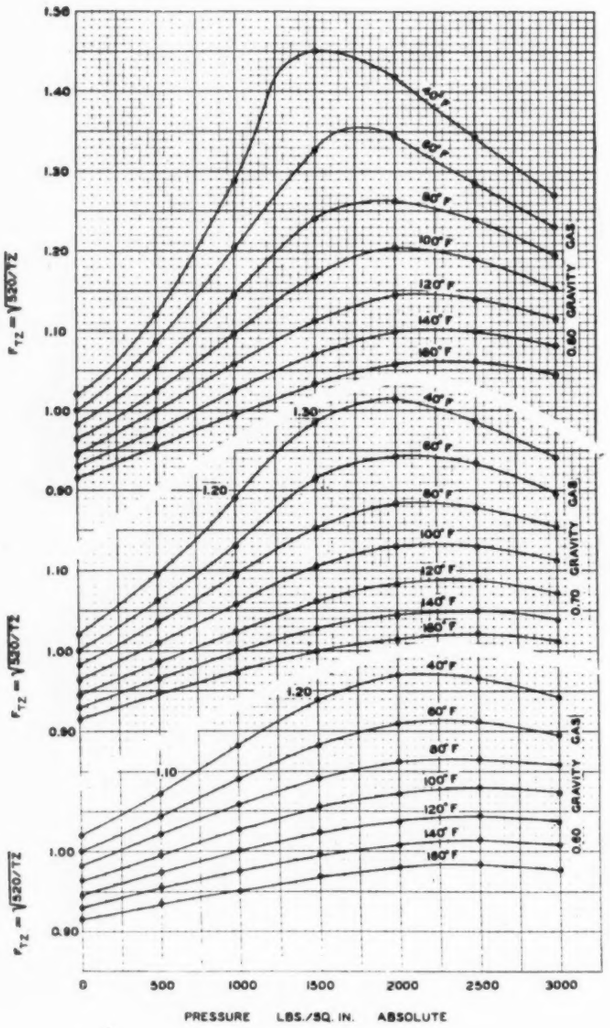
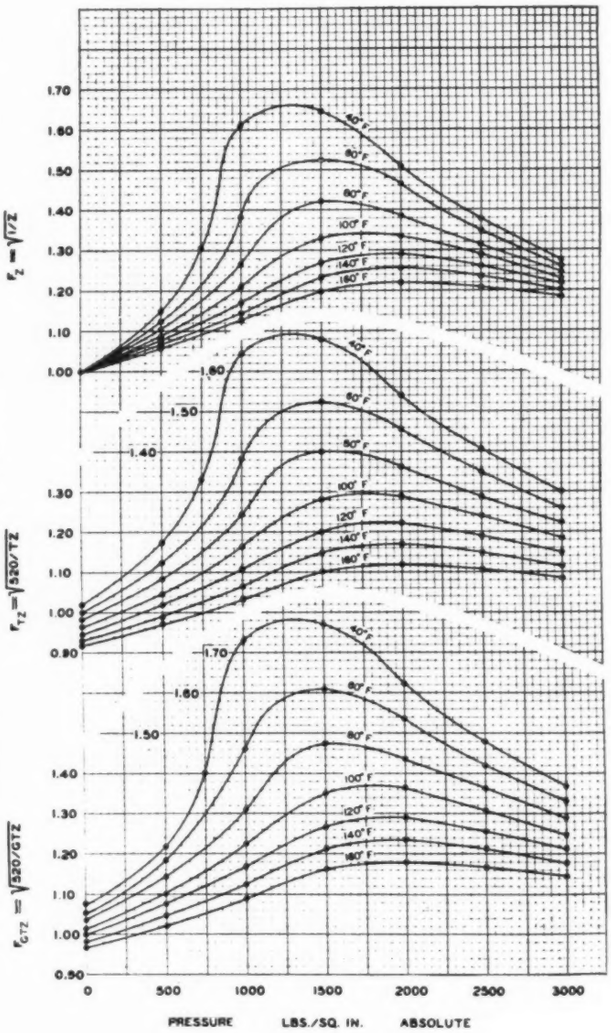


Fig. 9. Three types of meter factors for 0.9 gravity gases



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to make a meter correction factor for each gas.

If a series of relatively similar gases such as condensate well effluents were studied by themselves, it is quite possible that a liquid content would characterize the gases so that any deviations from a pseudo critical temperature-gas gravity curve could be measured by this variable. In that case, the gasoline content would not be used for individual gases but to establish the pseudo critical-gas gravity curves.

Metering of gases containing condensed liquids. Orifice meters are not generally considered satisfactory for measuring a mixture of two phases. Condensate well effluents are normally in two phases, however, and most rich high-pressure gases form a liquid phase during pressure decreases occurring with flow. The previous discussion of metering assumed single-phase flow but the need for a meter to handle two phases is increasing.

Many operators separate the liquid from the gas phase just prior to metering to eliminate the difficulty of handling gas containing liquid. In some cases the liquid is dumped back into the gas line below the meter, thus avoiding liquid accumulation at the orifice plate.

Until recently the prospect of metering mixtures of liquids and gases did not appear to be very great; however, two facts are now available that increase the possibility of two-phase metering. First, it is possible to make the stream homogeneous to the extent that it can be properly sampled.[16,17] Second, the density of the flowing stream can be computed regardless of whether a single phase exists or whether a small quantity of liquid is present.

Operators report satisfactory mechanical operation of meters if the velocities are high enough to give adequate dispersion of the liquid to simulate an homogeneous fluid. The recent tests of sampling two-phase flow should increase the knowledge of the homogeneity of the two-phase streams. If the mechanical devices can be assured to give the correct differential across the orifice, small amounts of liquid at high pressure are not likely to invalidate the usual density calculations.

When metering high-pressure gases containing a liquid phase, special precautions must be observed when obtaining the gas gravity. Satisfactory sampling of the flowing stream followed by separation of the liquid and gas at a lower pressure, below 500 lb., should provide data for computing the flow

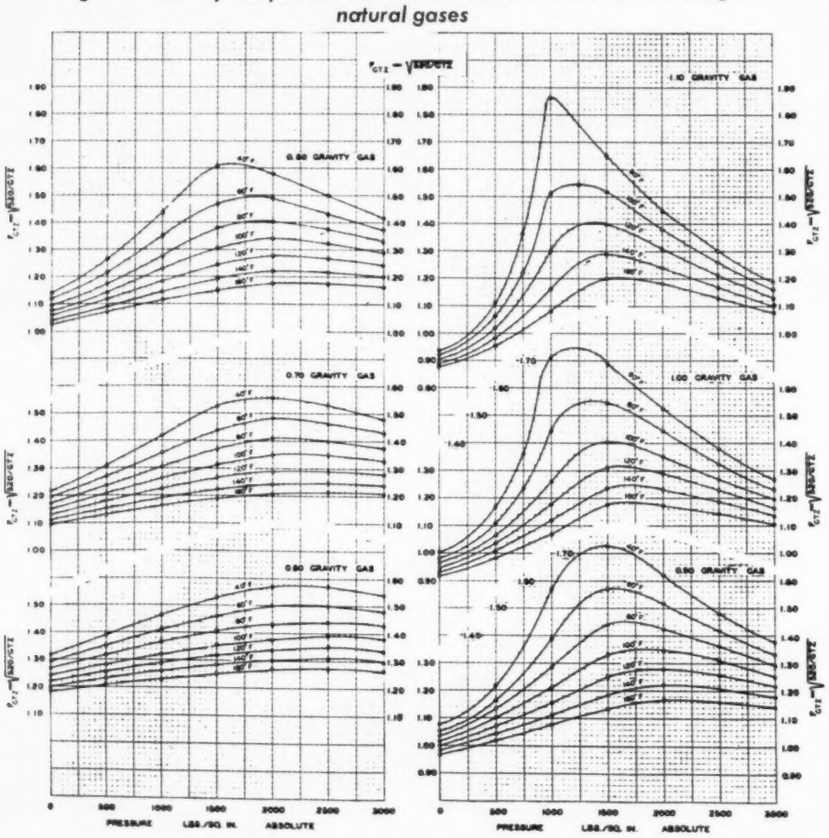
TABLE 12

Typical calculation of meter factors—Grapeland and Oklahoma City gases

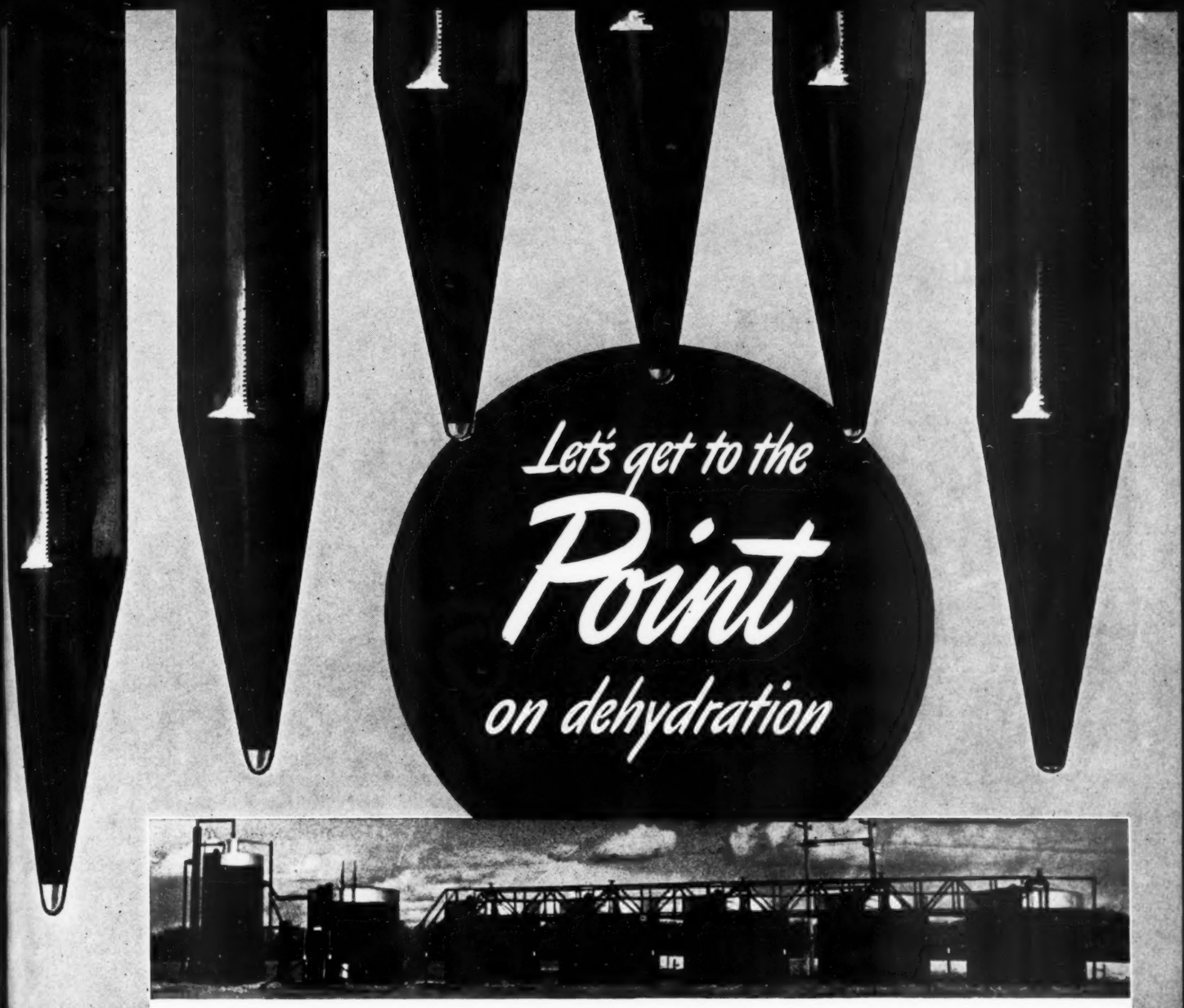
Gas gravity = 0.600. pTc = 359. pPc = 672.

Temp., °F.	Pressure, lb. per sq. in. abs.	pT_R	pPr	Z	$\frac{1}{Z}$	$\sqrt{\frac{1}{Z}}$	$\sqrt{\frac{520}{TZ}}$	$\sqrt{\frac{520}{GTZ}}$
40	500	1.392	0.744	0.902	1.109	1.052	1.072	1.388
	1000		1.488	0.812	1.231	1.110	1.132	1.463
	1500		2.232	0.738	1.356	1.163	1.188	1.531
	2000		2.976	0.700	1.430	1.196	1.220	1.572
	2500		3.720	0.703	1.422	1.192	1.215	1.570
	3000		4.464	0.729	1.371	1.170	1.192	1.540
60	500	1.450	0.744	0.916	1.091	1.044	1.044	1.350
	1000		1.488	0.840	1.190	1.090	1.090	1.409
	1500		2.232	0.781	1.280	1.131	1.131	1.401
	2000		2.976	0.744	1.345	1.160	1.160	1.499
	2500		3.720	0.740	1.352	1.162	1.162	1.500
	3000		4.464	0.761	1.312	1.145	1.145	1.480
80	500	1.504	0.744	0.925	1.081	1.040	1.021	1.318
	1000		1.488	0.861	1.160	1.078	1.059	1.365
	1500		2.232	0.811	1.232	1.110	1.091	1.406
	2000		2.976	0.779	1.284	1.132	1.112	1.433
	2500		3.720	0.774	1.292	1.137	1.115	1.440
	3000		4.464	0.790	1.268	1.128	1.108	1.430
100	500	1.560	0.744	0.936	1.069	1.034	0.995	1.280
	1000		1.488	0.880	1.136	1.066	1.027	1.318
	1500		2.232	0.835	1.199	1.095	1.056	1.355
	2000		2.976	0.808	1.238	1.112	1.072	1.375
	2500		3.720	0.797	1.254	1.120	1.080	1.393
	3000		4.464	0.813	1.230	1.110	1.070	1.380
120	500	1.618	0.744	0.946	1.058	1.029	0.974	1.255
	1000		1.488	0.895	1.119	1.058	1.001	1.290
	1500		2.232	0.857	1.168	1.051	1.023	1.324
	2000		2.976	0.834	1.200	1.095	1.036	1.338
	2500		3.720	0.822	1.218	1.104	1.045	1.352
	3000		4.464	0.835	1.198	1.094	1.036	1.337
140	500	1.671	0.744	0.951	1.051	1.024	0.954	1.231
	1000		1.488	0.909	1.100	1.049	0.975	1.260
	1500		2.232	0.872	1.146	1.072	0.998	1.29
	2000		2.976	0.853	1.171	1.081	1.007	1.300
	2500		3.720	0.842	1.188	1.090	1.014	1.305
	3000		4.464	0.855	1.170	1.081	1.007	1.300
160	500	1.727	0.744	0.959	1.042	1.020	0.934	1.208
	1000		1.488	0.921	1.075	1.038	0.950	1.228
	1500		2.232	0.892	1.120	1.059	0.969	1.251
	2000		2.976	0.871	1.149	1.072	0.980	1.270
	2500		3.720	0.865	1.156	1.075	0.984	1.271
	3000		4.464	0.875	1.142	1.069	0.976	1.263

Fig. 10. Gravity-temperature-deviation: Meter factors for average natural gases



16. Flaitz and Parks, *Pet. Tech.*, September 1941.
17. Bennett, Williams, and Kimmell, Unpublished paper, 1941.



THE primary objective of dehydration is the attainment of "pipeline" oil... but to the producer, the *secondary* objectives of dehydration are highly important. While it is true that oil cannot be profitably sold unless it meets pipeline specifications, it is equally true that BS&W cuts well under actual maximum BS&W allowables permit a margin of safety that is obviously desirable... that obtaining the minimum cut with the greatest dehydrating economy also is extremely important. These factors, the lowest possible B. S. and W. content and maximum dehydrating economy, are the measures of treating efficiency. Tret-O-lite Service and Tret-O-lite Compounds are designed to give maximum demulsification effectiveness. Your Tret-O-lite representative can tell you how and why.

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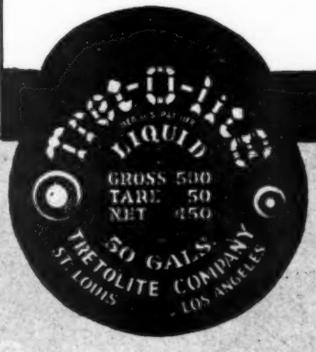

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DEHYDRATING DESALTING

stream molecular weight. A gravity balance test could be devised to operate on the atmospheric pressure gas with corrections for liquid recovered in a specially designed receiver.

Recommended procedure for establishing meter factors. The following procedures for establishing standard meter factors including the deviation from ideal gases are as follows, depending upon the accuracy desired:

1. For the highest degree of accuracy, a gas analysis should be obtained to eliminate any doubt regarding pseudo criticals. The errors in metering due to gas density alone should not exceed 1 percent on the average.

2. For average metering of high-pressure gases of varying gravity, representative analyses should be obtained to be used to establish a curve of gas gravity versus pseudo critical temperature and pressure. From this curve, a chart or series of tables should be prepared giving the meter factors at even gas gravities. The errors in metering due to gas density alone should not exceed 2 percent on the average.

3. For cases in which analyses are not available, the meter correction factors of Fig. 10 are recommended. The error in metering due to gas density should not exceed 3 percent for the average gas, but an unusual gas at conditions to give low compressibility factors might be in error by as much as 10 percent.

4. Further study of gasoline contents may indicate their usefulness for certain groups of gases in establishing the correct pseudo critical conditions versus gas gravity.

5. Metering of gases above 1000 lb. known to contain less than 10 percent of liquid by volume should be computed as if the entire stream were a gas phase provided the meter operation is indicative of uniform dispersion of the liquid in the gas passing through the meter run.

6. The compressibility factor plot, Fig. 1, should be used for natural gases containing less than 7.5 percent N_2 and 2 percent carbon dioxide. For appreciably higher concentrations, the measurement of the compressibility factors is recommended for reliable results.

7. The double importance of temperature because of its effect on compressibility factors as well as on the ideal volumetric expansion should be recognized in high-pressure measurement.

☆ ☆ ☆

P 989.1

Most Bureau of Mines Projects Given Approval

A MAJORITY of the wartime construction projects of the U. S. Bureau of Mines, ordered suspended by the War Production Board in its order of October 20, have been given the "green light," after a hearing before the Facility Review Committee of the WPB, it is announced by Secretary of the Interior Harold L. Ickes.

In a letter from Ferdinard Eberstadt, vice-chairman of WPB, Secretary Ickes was advised that construction work on the Bureau's helium plants, explosives research laboratory, synthetic oil project, and pilot plants and laboratories working on aluminum may continue to completion, subject to limitations contained in previously issued Preference Rating Orders. A decision on two additional projects was deferred temporarily.

At the hearing held by the Facility Review Committee on November 16, representatives of the Interior Department and of the Bureau of Mines urged that the construction work on all the Bureau's projects essential to the war be continued. Representatives of the Bureau included the director, Dr. R. R. Sayers; Assistant Director R. S. Dean; H. P. Greenwald, superintendent of the Central Experiment Station, and A. C. Fieldner, chief of the Fuels and Explosives Service.

Failure to have permitted construction work to proceed on the helium plants, it was pointed out, would have meant that the Army and Navy would be unable to obtain enough of this non-inflammable, lightweight gas for its lighter-than-air craft and other uses, as the Bureau of Mines is the world's sole producer of helium. Construction is now proceeding at the Bureau's well-known Texas plant and at five other sites.

The Bureau is also permitted now to proceed on the construction of its pilot plant and laboratory working on the production of gasoline, fuel oil, and petroleum byproducts from coal by the Fischer-Tropsch method, and on plants to devise and test processes for production of alumina (for making aluminum metal) from low-grade bauxite and aluminous clays.

The projects on which a decision has been deferred include the construction of a pilot plant for production of zinc metal from zinc ores by the gaseous reduction method, and a pilot plant for the production of sponge iron by direct reduction of iron ores with solid fuels and with gas. Construction of both these plants was authorized by Congress in the 1943 appropriation bill for the Interior Department.

The letter from the WPB to Secretary Ickes with slight modifications in the interest of national security follows:
My dear Mr. Secretary:

The review of projects being prosecuted by the Bureau of Mines, has been completed in accordance with Donald M. Nelson's letter of October 20 and your reply of October 23.

The following projects may continue to completion, subject to limitations contained in preference rating orders previously issued by the War Production Board:

(a) Amarillo helium plant and Cliffside gas field.
(b) New helium plant.
(c) Four additional helium plants (estimated to cost $11,000,000).
(d) Fischer-Tropsch project.
(e) Building for research on explosives.
(f) Chemical - control laboratories for the alumina pilot plants, in the East.
(g) Lime-soda-sinter pilot plant, in the East.
(h) Aluminum pilot plant for extracting pure alumina from clay deposits, in the South.
(i) Pyrometallurgical alumina pilot plant, in the South.

Action on the following projects has been deferred, pending the receipt of additional information. You will be notified of the committee's findings within the next several days:

(a) Pilot plant for the gaseous reduction of zinc ores.
(b) Sponge iron pilot plant, Laramie, Wyoming.

It is the joint recommendation of the Facility Review Committee and the Bureau of Mines that the Sponge Iron Pilot Plant, Johnstown, Pennsylvania, be discontinued immediately.

Sincerely yours,
(SGD) F. EBERSTADT,
Vice Chairman.

☆ ☆ ☆

P 516.3
P 094.99

The practice of driving oil-well pumping equipment with a splashproof motor installed outdoors saves the cost of a motor house and reduces the amount of unsalvable material, but requires special maintenance attention to insure long motor life

PETROLEUM ENGINEER Exclusive Feature

by W. G. Taylor
Industrial Engineering Department,
General Electric Company

Care of Splashproof Motors Installed Outdoors

☆ **Although requiring greater maintenance attention than the more nearly weatherproof motor, splashproof equipment has proved its value in well-pumping applications**

ALTHOUGH many splashproof motors are in successful operation outdoors, largely in oil-well pumping service, it is generally recognized that they require more frequent maintenance attention to keep them in good operating condition and to prolong their useful life than the more nearly weatherproof, totally enclosed, fan-cooled motor. This is particularly true of splashproof motors in the oil fields, because there they meet much more severe service conditions than in most other industries.

A splashproof motor is open to the circulation of cooling air through the interior by means of fans on the rotor or shaft, and the windings are of course exposed to atmospheric humidity. Furthermore, well-pumping operation is usually intermittent, and motor insulation has a harder job of remaining intact under that condition than when operation is continuous. This is because the motor on intermittent operation alternately heats and cools, and the windings consequently expand and contract, making it easier for moisture to penetrate. When the motor cools, moisture from the atmosphere is likely to condense on the windings and other interior parts. The fact that so many splashproof well-pumping motors have been running outdoors for years on automatically timed intermittent pumping periods without failure, indicates that they "have what it takes" to meet such conditions, provided they are cared for properly.

Due to the fact that the action of the elements deteriorates the protective coatings on the windings and laminations, eventually making these parts vulnerable to moisture, dirt, rust, and grease, periodic attention to cleaning the ventilating passages, cleaning and re-lubricating the bearings, and renewing the protective coatings on windings and metal parts, will result in better performance and longer life of splashproof motors. About every two years the motors should be removed to a clean room for reconditioning. They should be completely disassembled and carefully inspected to detect any damaged parts.

W. G. TAYLOR

has been an industrial application engineer with the General Electric Company for many years, specializing since 1911 on the oil industry in its production, pipe-line, and refining branches, and identified with most of its major electrical problems and developments—A native of New York State, he graduated from Cornell University in 1907 as a mechanical and electrical engineer, with previous mechanical training in machine and locomotive repair shops—After taking the General Electric test training course, he served for several months as assistant engineer of distribution in the New York and Queens Electric Light and Power Company at Long Island City, New York, and then returned to General Electric—He is licensed as a professional engineer by the State of New York.

Solvents

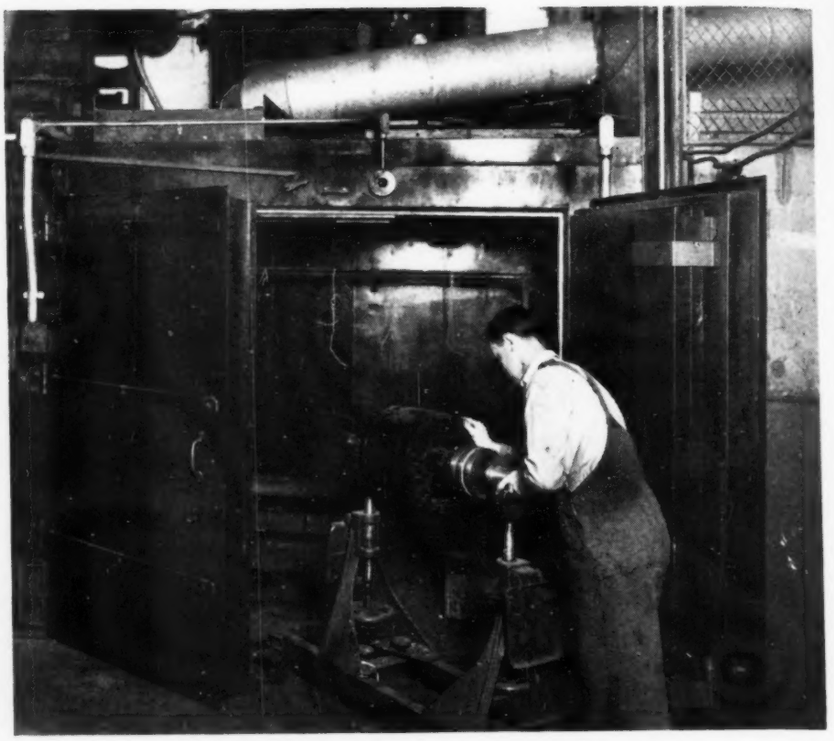
Carbon tetrachloride, or any of the several available non-explosive cleaning solvents, should be used to avoid the danger of explosion and fire that is present if gasoline or any similar hydrocarbon compound is used.

Note: The vapor of any of these cleaning solvents is heavier than air, and there is always danger of suffocation to the men using them. This cleaning should be done in the open air, or some positive means of avoiding accumulation of vapors should be provided.

Rotors

The rotors of squirrel-cage motors should be cleaned with a solvent to remove any accumulated dirt, after which any rust should be removed with fine sandpaper (not emery paper). When clean and dry, the rotors should be coated with a good grade of clear varnish or lacquer to protect them from moisture. To prevent injury to the bearings, they should be completely protected with a clean rag when the motor is disassembled.

The rotors of wound-rotor motors should be given the same treatment as the stators.



Electric baking oven for drying motor windings

Stators

The stator bore should be cleaned of dirt with a solvent, and any rust should be removed with fine sandpaper (not emery paper). Care should be taken during this operation not to damage the top sticks or end turns of the stator winding. When dry, any remaining dirt in the bore should be wiped out with a cloth or brushed out with a soft brush. A hand bellows or dry compressed air at low pressure (25 to 50 lb.) may be used, but care should be exercised not to blow dirt or chips into the stator winding.

The windings should be brushed free of dust, using a soft bristle brush, and then washed with a cloth or brush wet with carbon tetrachloride. As carbon tetrachloride is very volatile, it will not injure the insulation if not applied too generously.

Dry the winding by one of the following methods:

1. Place the stator in an oven and bake at a temperature not exceeding 90°C. (194°F.).

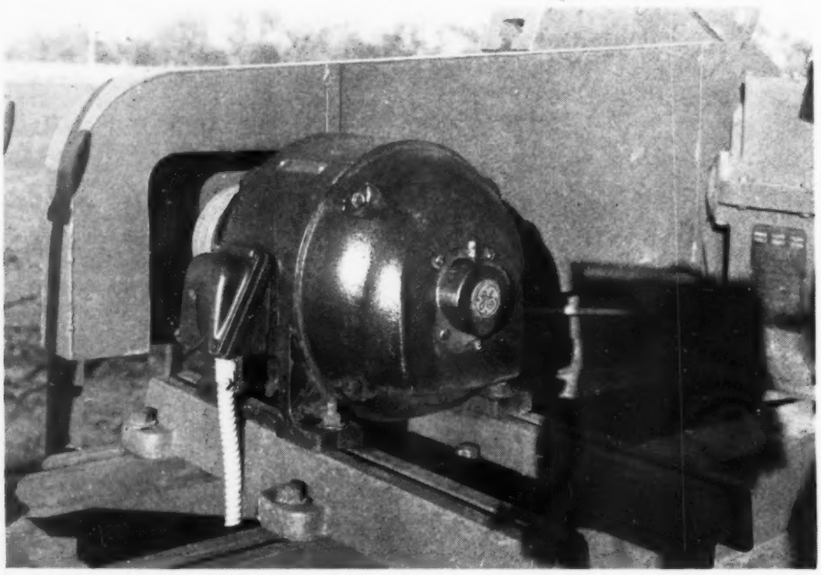
2. Enclose the motor with canvas or other covering, leaving a hole at the top to permit moisture to escape. Insert heating units or lamps to raise the temperature of the air within the enclosure to not more than 90°C.

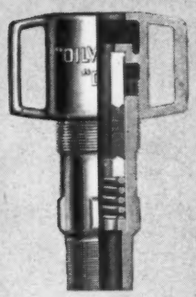
3. Pass current at low voltage through the stator windings. Increase the value of the current gradually until the winding temperature, as measured by a thermometer, reaches 90°C. Do not exceed this temperature.

Drying should proceed until the insulation resistance becomes practically constant. There are many ways of measuring insulation resistance, and any equipment available can be used if care is taken not to apply too high a voltage to the winding.

A megohmmeter provides the easiest method of reading insulation resistance, but if one is not available, the voltmeter method can be used. Two "B" batteries in series with a 150-v. voltmeter will be safe for taking readings of any wind-

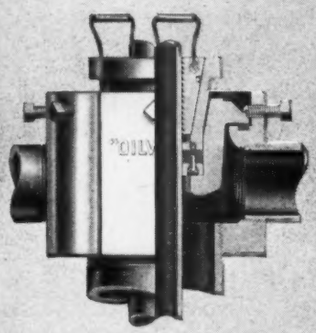
A splashproof motor is mechanically well protected against splashing and dripping water, but is open to the circulation of cooling air through the interior, and the windings are exposed to atmospheric humidity





"OILWELL" MODEL "D" STUFFING BOX

Simple and compact with low overall height . . . Parts and stuffing-box rings interchangeable through entire range of tubing sizes . . . Constant compression of packing by strong interchangeable spring . . . Extra-long top gland . . . Large oil reservoir.



"OILWELL" OCTAGON (TYPE 38) CASING HEAD

(Illustrated with "Oilwell" Slip-Suspension Tubing Hanger—Type "C")

Convenient octagonal body with straight sides and low overall height . . . Eight set screws help distribute pressure on packing . . . Semi-steel or cast-steel to suit well requirements.

"OILWELL" SLIP-SUSPENSION TUBING HANGER —TYPE "C"

Simple, sturdy construction . . . Hardened steel slips with convenient lifting handles . . . One-piece sanitized packing element.

"OILWELL" FORGED-STEEL PIPE SADDLES

Drop-forged steel bodies *fit the pipe accurately* . . . One-, two-, and three-clip styles with round or flat clips . . . Wide range of sizes with tapped or blind outlets.

"OILWELL" FORGED-STEEL SAFETY "C" LINK

Light weight and convenient handle make "hooking-on" an easier, safer job. This "C" link is representative of "Oilwell's" extensive line of knock-off equipment, including throw-off hooks, "E" links, knock-off blocks, turnbuckles, and dozens of other items designed to suit particular needs.

WHEN you put a piece of equipment on a well, you want to know that it is worth its salt—that it will give you its full share of reliable service. The quality that results in just that kind of performance is built into all "Oilwell" production equipment, from the largest item of machinery to the smallest part or accessory. All "Oilwell" products receive the same careful attention to design, material and workmanship.

Illustrated on this page are a few of the many items comprising "Oilwell's" extensive line of production equipment. The next time you're planning the equipping of a well or an entire lease, stop at the nearest "Oilwell" store. Friendly, competent supply men will gladly show you what they can furnish for your particular applications.

OIL WELL SUPPLY COMPANY

ings and will provide a testing current free from any ground. If a ground exists, they lack power to do any damage.

Connect the two batteries in series. Connect one side of the batteries to the frame of the stator, making sure to have good contact with bare metal. Connect the other side of the batteries to the voltmeter. Touch the free lead of the voltmeter to the point where the battery is connected to the frame. Call this reading E. Next, touch the free lead to one of the motor terminals and call this reading E_1. The insulation resistance is $R = R_1\left(\frac{E}{E_1} - 1\right)$, where R_1 is the resistance of the voltmeter. The voltmeter resistance is usually given inside the meter cover.

The insulation resistance in megohms must be greater than rated voltage divided by

$$\left(\frac{0.75 \times \text{hp.}}{100} + 1000\right)$$

For practical purposes this becomes 0.2 megohms for 220-v. motors, 0.4 for 440-v. motors, and 0.5 for 550-v. motors.

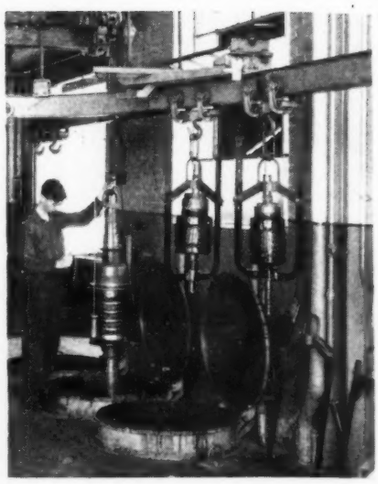
After the winding is free from moisture, and while still warm, a high-grade insulation varnish should be applied, either by spraying or brushing, or preferably dipping if possible. The stator bore should also be given a coat of varnish or lacquer to protect it from moisture. The stator leads, especially the section from the conduit box to the winding, should be treated with insulating varnish.

Bake the varnished stators for 6 or 7 hours at a temperature not exceeding 90°C., or merely allow the winding to dry at room temperature if a quick and air-drying varnish has been used. More than one coat of varnish may be required, depending on the condition of the winding.

The electrical manufacturer can supply insulating varnish suitable for definite operating conditions. Consult the manufacturer for recommendations.

Ball Bearings

The ball-bearing housing should be disassembled and all parts cleaned thoroughly with a solvent, or light oil heated to about 150°F. When the bearing is cleaned of old grease and completely dry, reassemble it in the housing until only the balls and cage to the outside of the motor remain exposed. Apply new grease, either by hand or from a tube, over and between the balls. The amount of grease to be used will vary with the type and frame size of the particular motor. The housing should be filled not more than one-third to one-half full; too much grease may cause excessive bearing temperatures and may cause grease to leak from the housing onto the windings.



Dipping tanks for applying insulation varnish to motor windings

When reassembling the motor, any V-grooves found in the housing lip should be filled with a fibrous, high-temperature sealing grease that will act as an additional protective seal against the entrance of dirt or foreign material.

It is desirable to run the motor with the relief plugs removed from the bearing caps for about one-half hour to allow any excess grease to be forced from the bearings.

Sleeve Bearings

The bearing housings should be washed out with a solvent. The bearing housing and lining should be completely dried, and before the end shield is assembled on the motor, the shaft journal should be covered with a film of lubricating oil.

Miscellaneous Parts

Before reassembling, clean any rusted parts thoroughly and apply a priming coat as recommended by the electrical manufacturer. Assemble and, if necessary, paint the complete motor.

Before starting sleeve-bearing motors be sure that the housings are filled with oil. A good grade of mineral oil of SAE-10 viscosity should be used. The drain plugs should be sealed with an oil-sealing compound such as recommended by the manufacturer.

Be sure that the rotor turns freely when disconnected from the load, and that it does not rub either on the stator laminations or on any foreign material in the air gap. Before the motor is placed in service, it is desirable to operate it without load long enough to determine that there is no unusual localized heating, and to check for the proper direction of rotation.

☆ ☆ ☆

Redistribution of Oil Country Tubular Goods

Redistribution of idle or surplus oil country tubular goods for authorized uses will be made as soon as some 10,000 oil and gas producers file inventory reports, Petroleum Coördinator for War Harold L. Ickes has announced.

Inventory sheets (OPC Form MA-2), together with detailed instructions regarding the type of information required, have been sent to all oil and gas producers.

The mandatory report calls for a tabulation of all oil country tubular goods in the operators' possession, wherever situated in the Continental United States or in Canada.

Explaining the need for the nationwide inventory, Deputy Coordinator Ralph K. Davies said:

"There is so great a demand for raw materials by all industries that it is absolutely essential that the oil industry use the materials it requires with maximum efficiency.

"The Nation's supply of oil country tubular goods must be used sparingly and only for essential, authorized programs. Thus, it is necessary that idle or surplus stocks be made available to all operators and, at the same time, that the materials be distributed only for approved operations.

"The present inventory will make it possible to utilize the oil country tubular goods for the most effective purposes."

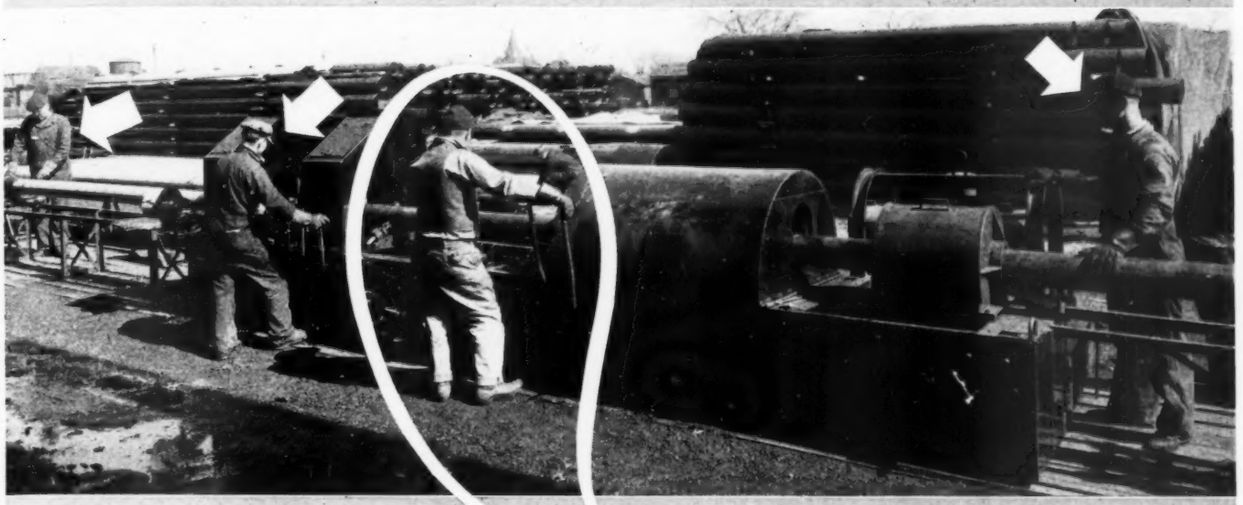
The inventory report was issued with the approval and under the supervision of the Materials Redistribution Branch of the War Production Board.

Operators must file a report, in duplicate, with the OPC Materials Division of the District Office in whose area the materials are situated.

An operator who has filed his report will be entitled to purchase his requirements of oil country tubular goods for an authorized work program from the idle or surplus inventories owned by other operators.

If an operator fails to file the inventory report he will be denied authority to acquire or use any materials for oil or gas production.

YESTERDAY THE HELPERS IN THIS CREW KNEW NOTHING ABOUT APPLYING NO-OX-ID RUST PREVENTIVE TO PIPE . . .



. . . BUT THIS MAN MADE THEM *Efficient Operators* IN ONE DAY . . . IT'S SO EASILY DONE

That's important these days with men going into the armed services and the consequent difficulty of keeping crews intact.

The machine illustrated is practically automatic. It coats the pipe surface with NO-OX-ID and applies the NO-OX-IDized Wrapper simultaneously in one operation. The heaviest manual labor is feeding the pipe at one end and removing the completely NO-OX-ID protected pipe at the other end.

NO-OX-ID is double acting . . . it prevents rust mechanically by excluding moisture and oxygen and chemically by inhibiting any underfilm corrosion which may be present. A combination of NO-OX-ID and NO-OX-IDized Wrapper provides pipe line protection under the most corrosive soil conditions. Pipe lines, laid a quarter of a century ago, are still in service requiring no maintenance through the years.

Dearborn engineers are at your service to help you solve your rust problems. Also to demonstrate how a combination of NO-OX-ID and NO-OX-IDized Wrapper provides complete protection and can be applied rapidly and easily by stationary machines such as illustrated, by travelling machines on the line, or by hand. Write for complete details. Dearborn Chemical Company, Dept. L, 310 S. Michigan Avenue, Chicago, Illinois.

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Manufacture of Lubricating Oils

Class Meeting No. 5 (continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

Leader: Is asphalt made from the sludges stripped of propane?

Pupil: It is stated that gas oil had to be added in order to be able to use the asphalt. They did a lot of work with propane; plant propane and pure propanes were used and they were not able to do any good at all with plant propane, but they stated definitely that the bad results of the plant propane were due to small percentages of butanes and not to propylene. I suppose it was just because the plant propane probably was not de-ethanized and contained some percentages of butane.

Leader: Does everybody understand this filter process? The type with a rotary drum and vacuum inside the drum flows the thin oil diluent through the canvas and leaves the wax cake on top of the canvas. When it is finally washed with propane, the cake is loosened and scraped off after the time cycle has been completed.

Pupil: We are going to use that on the residuum after removing wax distillates. We don't know what the refining process would be to get wax separation from petrolatum.

Leader: I am glad you brought this out because it makes an interesting comparison. What about refrigeration? Do you know what they would run? If you had one bbl. of oil weighing 300 lb. roughly, and wanted to cool it from 100°F. to 50°F. below zero, assuming a specific heat of 150 it would take 22,500 B.t.u. to cool the oil to minus 50°F. If by using 1 lb. you get 140 B.t.u., then you would have to have how many pounds of propane? About 160 lb. of propane would self-refrigerate that barrel of oil. So there is a lot of power when you have a ratio of 2 or 3 of propane to 1 volume of oil.

Pupil: In this process several jet condensers and heat exchangers were used to lighten the load on the compressor. One thing about propane refrigeration —it would be considerably more efficient, as it is in direct contact with the oil. It is possible to chill much faster; for propane dewaxing chilling at the rate of several degrees a minute can be done safely.

Leader: One question has been asked by several persons and that is, if a vacuum unit were available for de-asphalting, would it be any good? My opinion is that it would be advantageous, but when beginning from the ground up, the propane process would very likely justify itself rather than the vacuum process. Is Group 3 ready?

Pupil: This process is the same process as Group 1 gave, the Shell process. They covered the process rather thoroughly, so there is nothing left except possibly the quality of the products that are manufactured. In the original description of the process a table was shown, giving the quality of the products. We shall not attempt to reproduce it in its entirety.

	Dewaxed oil	*Wax*
Gravity, A.P.I.	22.0	
Specific gravity		0.918
Vis. SSU 210°F.	105	72.0
Pour point	—10	

Leader: Are those Mid-Continent products?

Pupil: Yes. The article says further processing is required to bring the oil up to the proper pour point and perhaps further solvent refining and that the pour point is rarely increased more than 10° in this subsequent process. The oil finishes up bright and will not have a cloud. The wax product is quite dark and asphaltic. Asphalt was removed in the dewaxing process. The product has a viscosity of 72 sec. at 210°F. The wax distillate charged to the presses at the plant is only about 140 viscosity and the actual wax has a viscosity of about 50 sec. at 130°F.

Leader: Any questions? I should like to ask one. Could you use this for commercial results?

Pupil: We doubt it.

Pupil: They could have de-asphalted before they dewaxed.

Pupil: It was, but not acid-treated.

Leader: Is Group 4 ready?

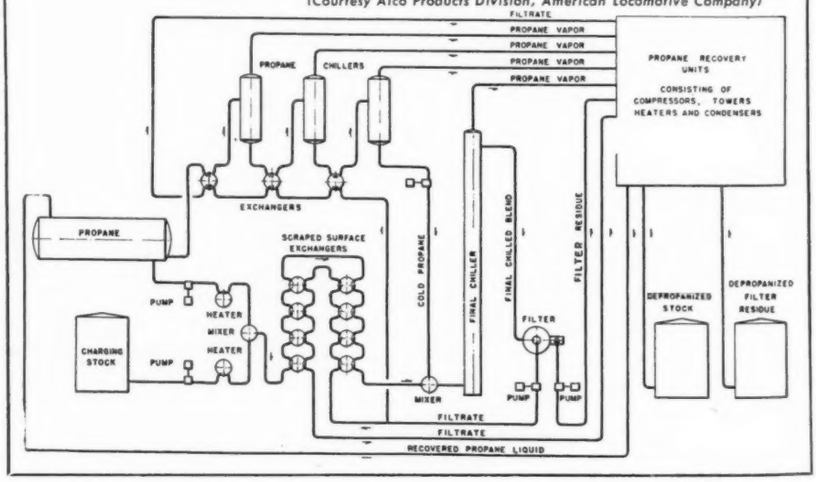
Pupil: Yes. We have no particular process. We based it on the Kellogg process and partly on the Sun-Alco process, and added a few ideas of our own of what might be worked out if we put our shoulders to the wheel. Take a top crude and do a little de-asphalting. One company uses a ratio of top crude and propane of 1 to 9 on their de-asphalting process, which is considerably higher than Kellogg recommends. Kellogg says 1 to 1 is sufficient.

Leader: Our author gives 9 to 1 ratio as typical.

Pupil: Kellogg says in describing this flow sheet it is 1 to 1. Of course the asphalt is reduced. The asphalt might be turned to sludge or to something else. This is a 2-stage affair, similar to

Fig. 6. Sun-Alco propane dewaxing process

(Courtesy Alco Products Division, American Locomotive Company)



the settlers that have been used before. We had planned to obtain a separation and get further separation as a matter of cleaning up; more a matter of cleaning up than anything else. The temperature would be controlled by tying in the propane system. There is sufficient propane that we can refrigerate it and keep the temperature where we want it, 110 or 120. We come out of that with a de-asphalted oil and then dewax it. We will dewax in 3 parallel facilities, fill one, chill one, and run one. In that manner we can do it as fast or as slow as we want to. The author says it makes no difference how fast you bring it down. That will be auto-refrigeration and the ratio at that point should be about 5 to 1, according to Kellogg. This will come out at minus 40. It then goes through a vacuum filter to take the waxes out. After recovery of propane distill this wax to get a sweatable wax and residuum that will go to cracking stock. Maybe we can crack some of those ceresins and obtain more wax. We will drop our wax out of the filter and acid-treat under pressure, and after we have acid-treated, we will neutralize and take the neutralized, acid-treated oil over the depropanizer and take the oil stock we have to a vacuum distillation unit. In that vacuum distillation unit, we will get our neutral oil cuts and bright stock cuts to go straight to the filter house. Assuming they have already been acid-treated, de-asphalted, and dewaxed, and by varying operation on the vacuum unit you should be able to take off whatever grade of neutral oil you want. We would plan to take bright stock to the contact plant and neutralize with clay. The heavy bottoms would go back to cracking stock. This sludge —we will be treating with acid in the presence of propane—according to the author, is an item of some importance. Due to the thinness of the mixture, separation is obtained with a fairly quick break and not much loss of oil. Propane helps the work of the acid.

Leader: Isn't part of that due to the low viscosity?

Pupil: Yes. This acid treat also would probably be tied on to the compressor so a constant temperature could be obtained. The author mentions that sometimes they save several small dumps to keep the temperature from becoming too high. It would be a simple matter to keep that temperature wherever you want it.

Pupil: Out of all this can we determine where the acid treat should fit into the picture to do the most good—ahead of dewaxing or after dewaxing?

Pupil: We do get an increase in the pour point with acid treat.

Leader: Yes, we usually do, but if you had already removed most of your asphalts, you should not get very much. All right, for acid-treating in the final stage, what favors treating in solution?

Pupil: In the final stage additional asphalts have been removed in the fractionation.

Pupil: Group 4 waited until after they had acid-treated before they removed the asphalt.

Pupil: They have traded something that could later be cracked.

Pupil: The major objection to treating in solution is that when the propane or naphtha are removed it is likely to discolor the oil by oxidation.

Pupil: Kalichevsky says that is true with naphtha, but not with propane due to lower distillation temperatures with the latter.

Pupil: Yes, that is one advantage of propane.

Pupil: If you acid treat in the final stage when the problem is both to dewax and to de-asphalt with propane, and de-asphalting has not been done, then the final treatment would require very little acid because you are guarding against oxidation and will not need so much acid as is necessary when treating before the final stage.

Pupil: You can still treat with solution in the final stage, can't you?

Pupil: They have already de-asphalted once.

Leader: The treat is not quite final, so it should be considered intermediate.

Pupil: Concerning Standard's process, they state that they finish with gas oil after their 20-lb. acid treat, and then they used 1 lb. per bbl. of acid-treated clay to contact with.

Pupil: Perhaps we misunderstood about bringing the oil in contact with acid again. You could even go as low as ½ lb. per bbl.

Pupil: No, they started with a reduced crude that had some waste gas oil in it and then fractionated that out in the final stage.

Pupil: The same argument applies, for you de-asphalt twice.

Pupil: We thought a lot about that,

(Continued on Page 78)

Fig. 7. Effect of molecular weight of saturated hydrocarbon solvent on volume percent asphalt precipitated from topped Poso Creek residuum (10 volumes solvent at 80°F.)

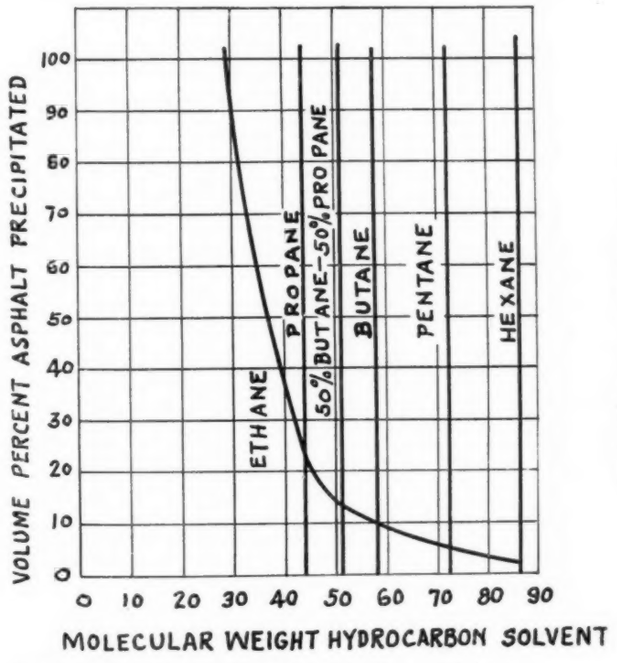
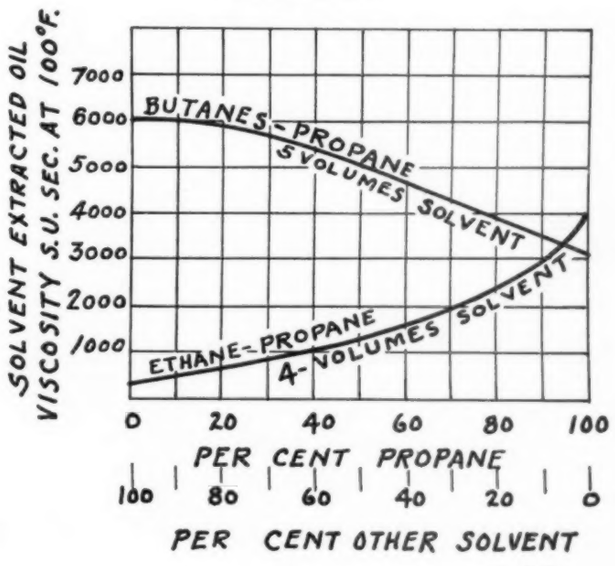
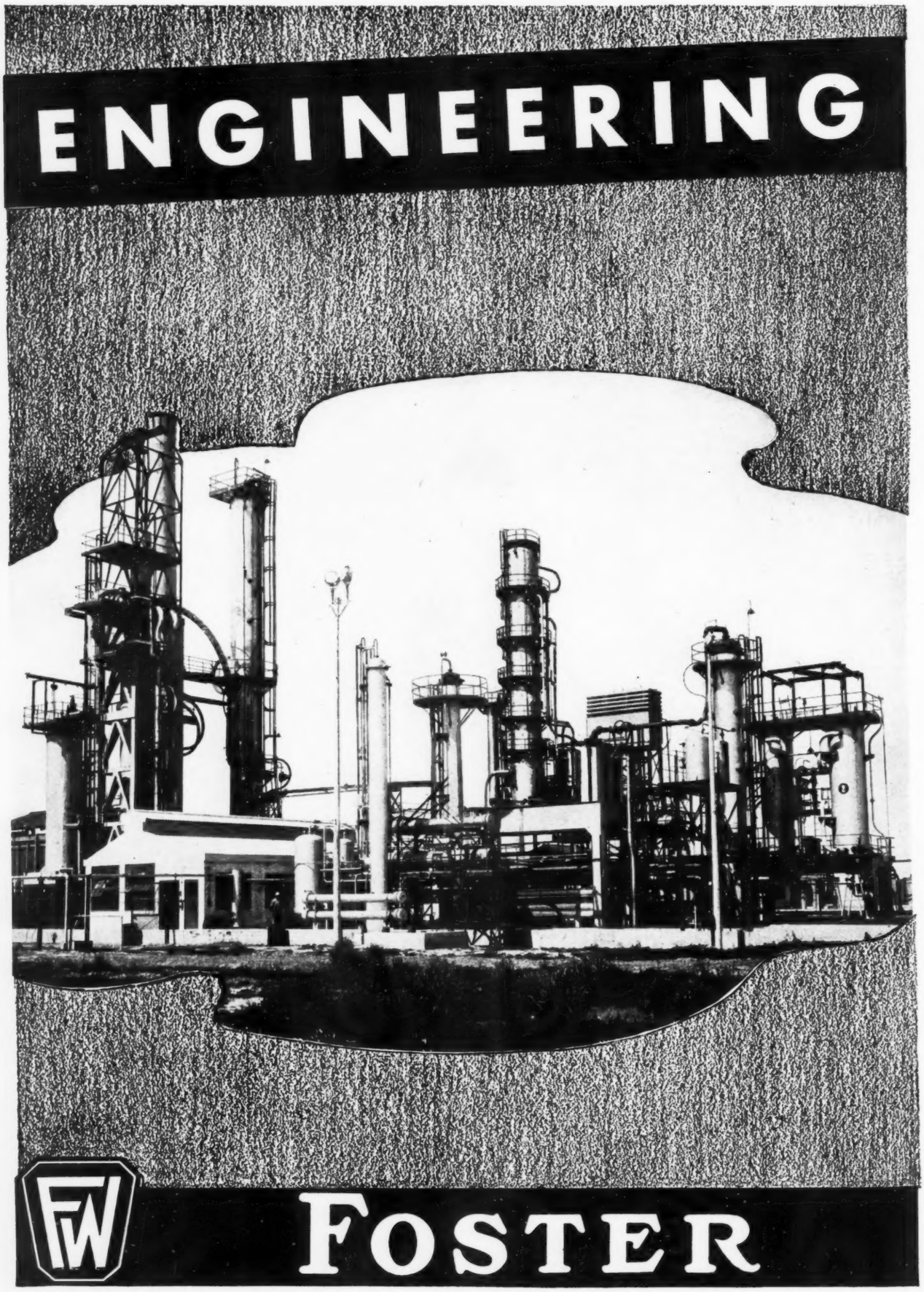


Fig. 8. Effect of proportion of butanes and ethane in propane on viscosity of oil extracted from Poso Creek residuum at 80°F.

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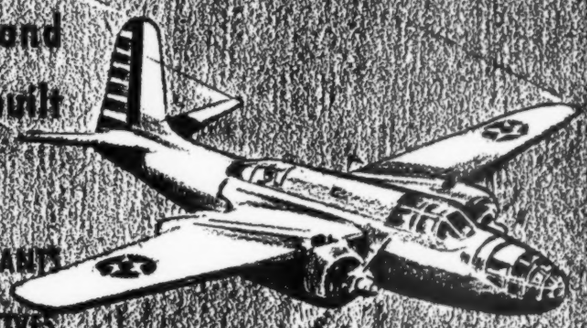

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(*Continued from Page 75*)

and undoubtedly you get less acid loss in treating with solution. You can't afford to take out your propane, make your distillation, and then put it back in again. It is cheaper to process the gas oil.

Pupil: We can make a quality of oil by this process that we cannot with final acid treat. Do we agree on that?

Leader: I think we might.

Pupil: I can't see the logic in de-asphalting in three places.

Pupil: That is to improve the viscosity index number and color, etc.

Pupil: We want our viscosity index number improved so we won't lose some of it in further processing.

Leader: I don't believe any of you have enough data to balance it out. The points you make of improving your chemical consumption at least has merit. The point of improving the yield is good.

Pupil: Concerning acid-treating the gas oil to the cracker, would there be any advantage in having the sulphur content reduced?

Leader: Yes, there would be some advantage.

Pupil: In the matter of acid treating before dewaxing, if one were not making a marketable petrolatum and wanted a good color to begin with, it seems foolish to remove all the asphalt.

Leader: It seems that most of you think it should be in solution, but we didn't agree at what stage.

Pupil: When you acid-treat in solution, you have a mixture of sludge, acid, and propane; isn't that a difficult problem to handle?

Leader: I think your sludge separates out rather clearly and may be handled by feeding into a Magma pump or some such pump, and pumping it off.

Pupil: How do you separate the propane?

Pupil: It is steamed. To go from a pressure of 200 to 25 will remove most of it, but in the 25-lb. column steam is used.

Leader: We will now have Group 5.

Pupil: We began with the Sun-Alco process. This was designed to handle Pennsylvania oils and has been adapted to use Mid-Continent Oils. Twenty-five hundred bbl. per day of long residuum is passed through a heater and mixed with an equal quantity of liquid propane in a mixer. The mixture is passed through chillers to insure slow rate of cooling and comes from the chillers at a temperature of approximately 25°F., then goes into another mix in which cold propane is added, 10,000 bbl. per day. From there it passes to a final chiller and is chilled by auto-refrigeration and the propane vapors taken off the top, and the chilled residuum goes through a rotary filter and a filtrate comes off. The stream is split, and the temperature is minus 40°F. The split stream is taken back to the chillers and is used as a refrigerating medium for the first chilling. From there the filtrate is taken over into the still and propane recovered. The depropanized stock is taken through the heaters. The other part of the split stream goes through various chillers that aid in cooling the liquid propane that goes into the cold propane mixture. The propane has been cooled to minus 45°F. in order to obtain a temperature of minus 40°F. on the stock; also the wax and wax asphalt mixture comes off the filters and is taken through a heater. You have a depropanized filter stock that is taken through the heater and various towers where the wax comes off. The wax is also distilled and a cracking stock obtained that is much the same as the foots oil and crude scale wax, which goes to the sweaters.

Here is your petrolatum and the heavy waxes. The bottoms are tar and can be sent over to the pressure stills and cracked into coke. Somewhere along this line using Mid-Continent stock, you are going to have to acid-treat and our idea was that the only acid treat you would need was stabilizing for oxidation values. All of these streams must be filtered as well, either by percolation or by contact.

Pupil: Are those batch chillers?

Pupil: No, continuous operation.

Pupil: Do you use ammonia in the first cooler?

Pupil: No, liquid propane. You split the filtrate stream and part of it goes back through the chillers to provide the cooling medium. It is just an exchanger. The system is designed to insure slow rate of cooling and is used on stocks going back through.

Pupil: I read that this is part of the Sun-Alco process. Where we have used propane cooling, they used ammonia cooling.

Pupil: They have 15,000 bbl. per day coming off already cooled to minus 40°F. They have a lot of refrigeration that they can use before beginning to strip the propane. One of the claims for this process is that the only part that is held under pressure is the tubular equipment, so the expense for pressure vessels is very small.

Leader: The Kellogg process indicates that sludge is separated without additional working over of the sludge.

Pupil: In that process, do you remove asphalt or solvent anywhere, or take the asphalt and wax off together?

Leader: They are removed separately.

Pupil: I read that 70° to 110°F. was required for de-asphalting.

Pupil: In the laboratory work done by Standard Oil, they state that the solubility of asphalts in propane was governed by the temperature, and as you increase the temperature the solubility decreases in propane.

Leader: Let's go back to an elementary picture. We introduce the oil and propane into one common layer. What happens when this propane and oil go together? What would you say happened to the solvents?

Pupil: As the temperature increases, the bottom layer will became larger.

Pupil: Up to a certain point.

Pupil: There will be no oil in the propane if temperature is increased.

Leader: We will hold that question in abeyance. I think it is important to use progressive steps. We are talking about the ability to precipitate the asphalt. I should like to suggest we look at Fig. 7 on page 94 of our text. (See Fig. 7 of this article). That is a very impressive array of information that shows immediately what happens to the heavier hydrocarbons. In ethane you obtain up to 100 percent precipitation. This topped residuum is uniformly handled with 10 volumes of solvent at 80°F. You will notice that propane is right at the turning point on the curve. The suggestion is made that when the hydrocarbons are lighter than the propane, there is a precipitation of heavy oil fractions with the asphalt. So that is not a desirable trend. If you want heavy hydrocarbons in the oil you should use solvent that will not cause them to precipitate. Propane seems to be the happy medium. Fig. 8 in the text (see Fig. 8 of this article), I think, is interesting as it shows what happens when you get a ragged separation in an oil refining propane with some ethane or butane mixed in it. You can see that we immediately throw down a lot of oils we are not looking for and don't want. Note 100 percent ethane, which is the bottom portion of the lower curve. The viscosity must be approximately 300 for the extract precipitated from the residuum—300 sec. at 100°F. So that again tells us what we saw in Fig. 7. We go on up the curve to pure propane and see it has the best asphalt precipitation. We use the term asphalt very liberally. If you happen to get some butane, you will notice that the curve starts up. Another comment is that you can vary your proportion of solvent. If you start using ethane you are complicated with high vapor pressure, so you would have to design for something around 1000 lb., if you had a temperature of 100°F., whereas with propane it is about 200°F., so that again brings propane into the foreground as an important solvent.

(*To be Continued*)

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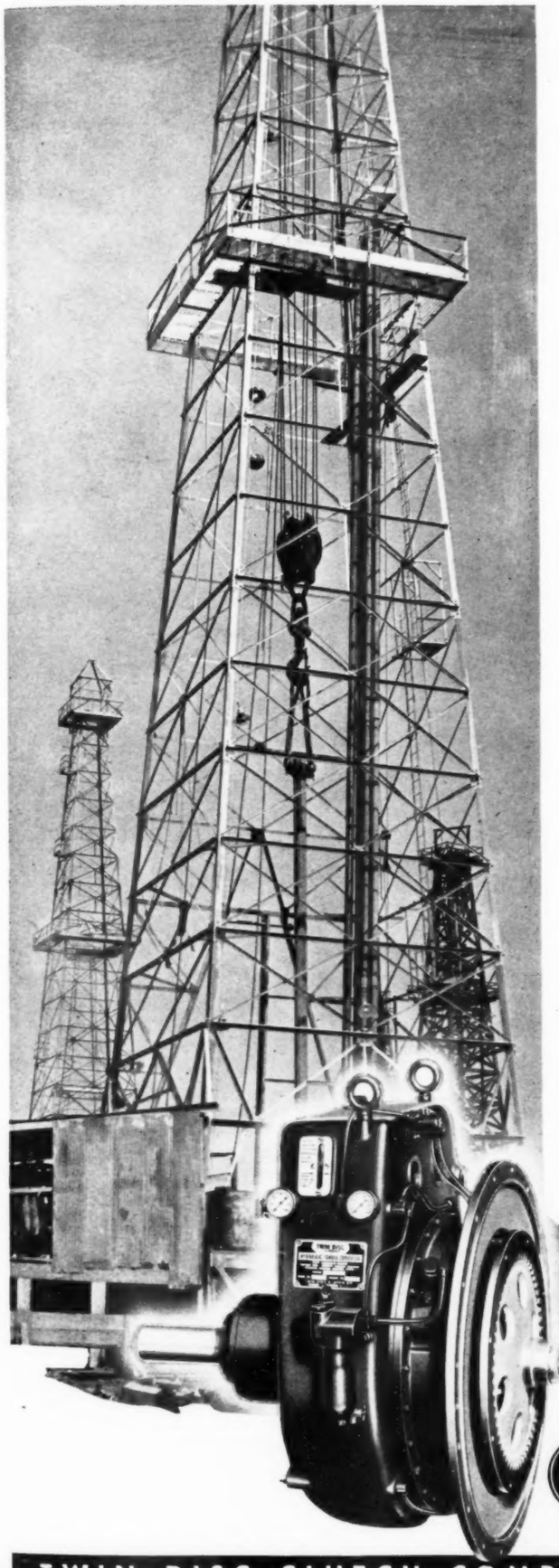

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Absorption Oil in the Cycling Plant

PETROLEUM ENGINEER Exclusive Feature

☆ Utilization and reclamation of absorption oil extremely important to maintenance of high plant operating efficiencies

by J. A. Grimshaw

Chemist, Wardner Plant, The Chicago Corporation

IN high-pressure cycling plants supplied by condensate gas wells whose hydrocarbon fractions have boiling points as high as 500 to 600°F., it is necessary to arrange the plant to produce two products. First, a gasoline with controlled end point; and second, a kerosine whose specifications will be determined by the gasoline specifications, insofar as the end point of the gasoline affects directly the initial boiling point of the kerosine. There are several types of cycling plants being supplied by condensate wells. The absorption plant has been found very successful in obtaining complete recovery of the condensate. Although different types of absorption plants include different features, depending on operating conditions, their purpose is the same. This articles does not apply to any one particular type of absorption plant, but deals with features common to most plants of this type.

Absorption Oil

Absorption oil generally is a gas oil; that is, a light oil, but one that is heavier than kerosine. The distillation range from the initial boiling point to the end point is usually about 100°F. A typical absorption oil has the following characteristics: gravity, A.P.I. 35 at 60°F.; color, light yellow; initial boiling point, 493° F., and end point, 610° F. Its color may be anything from white to a light yellow. It has a narrow boiling range because the heavier hydrocarbons are poorer solvents, and the lighter hydrocarbons can be distilled off in processing the gasoline and kerosine products. It is an ideal absorbing agent, because hydrocarbons being mutually soluble in one another, the absorption oil can absorb or pickup the fractions of gasoline and kerosine from the gas stream and release them under proper conditions.

J. A. GRIMSHAW

attended Wayne University, majoring in chemistry—Attended Texas A. and I. College taking Natural Gas Cycling Course—Was employed by city of Corpus Christi, Texas, for three years —Later worked for E. W. Saybolt and Company —For the last two and one-half years has been chemist for The Chicago Corporation, formerly the Corpus Christi Corporation, in the company's Wardner plant near Bishop, Texas.

Absorption oil is thus returned to its original form to repeat the process.

Absorption oil in the plant circulation system is known as "lean oil" before it comes in contact with the gas and after it has been denuded of its desired fractions, and as "fat oil" after it has been in contact with the gas until stripped of the absorbed hydrocarbons.

Typical Circulation System

Obviously, the most important action of the absorption oil occurs in the absorption tower or column. The function of the tower is to bring the incoming or wet gas and the absorption oil in contact so that the soluble hydrocarbons of gasoline and kerosine may be absorbed by the oil. The lean oil is introduced above the top tray in the absorber and flows downward over the trays, which increases the efficiency of the absorbing qualities of the lean oil by presenting more surface to the wet gas. The wet gas enters below the bottom tray and travels upward "through" the lean oil. A number of factors affect the efficiency of the absorptive qualities of the oil in the absorbers. The temperature of the gas and oil must be comparatively low. The amount absorbed depends on the pressure carried in the absorber, as it does in any case where there is no chemical reaction. The number of trays in the absorber and the amount of oil being circulated also are important factors. The lighter hydrocarbons that are not absorbed by the oil pass through the oil and out the top of the absorber. At this point they are picked up by the compressors and returned to the formation through the injection well.

Heavier hydrocarbons absorbed by the oil leave the tower from the bottom, this oil being known as "fat oil." The oil passes into a high-pressure vent tank, in which the pressure is reduced, then to an intermediate vent tank where the pressure is reduced still further and finally to a low-pressure vent tank where the minimum low pressure desired is obtained. The initial pressure and the minimum pressure desired govern the number of vent tanks necessary. The fat oil is then discharged to a heat exchanger, either under its own pressure or by pump pressure, to receive a preliminary heating from the lean oil from the last fractionating still. From the heat exchanger the fat oil goes to a gas-fired heater for further heating, then it enters the primary still, where the gasoline fractions are recovered.

An example of fat oil heating in a cycling plant is as follows: The tem-

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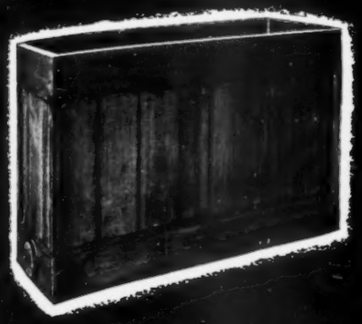

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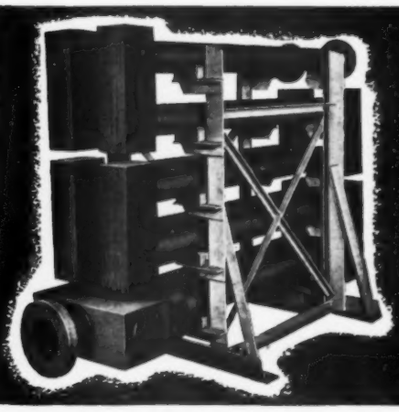

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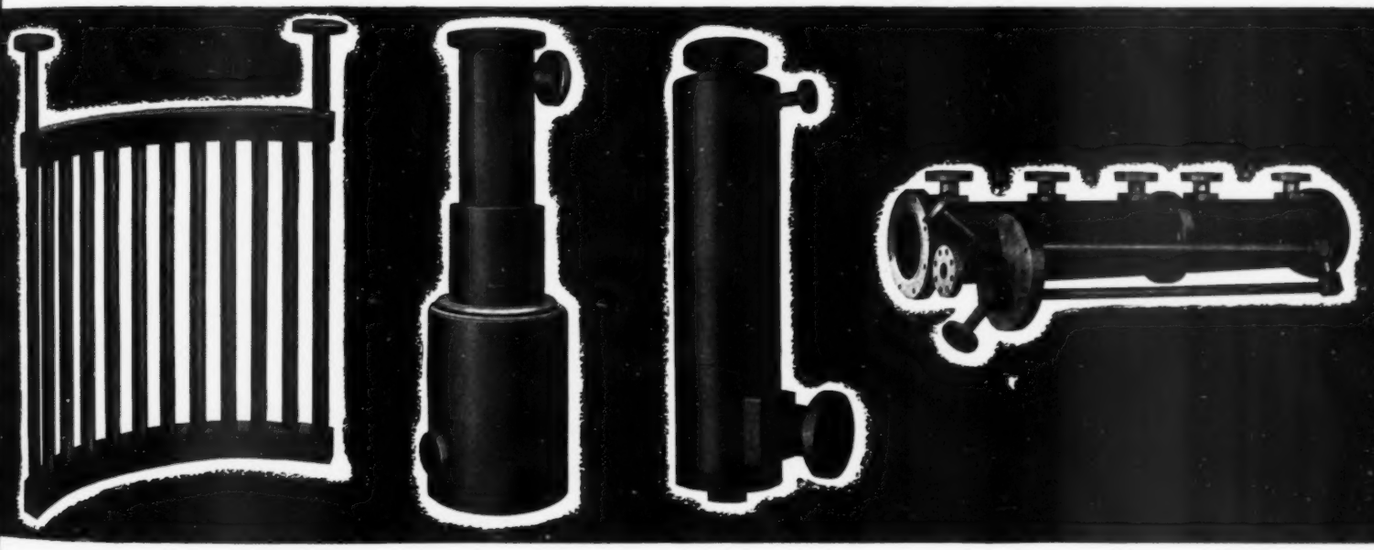

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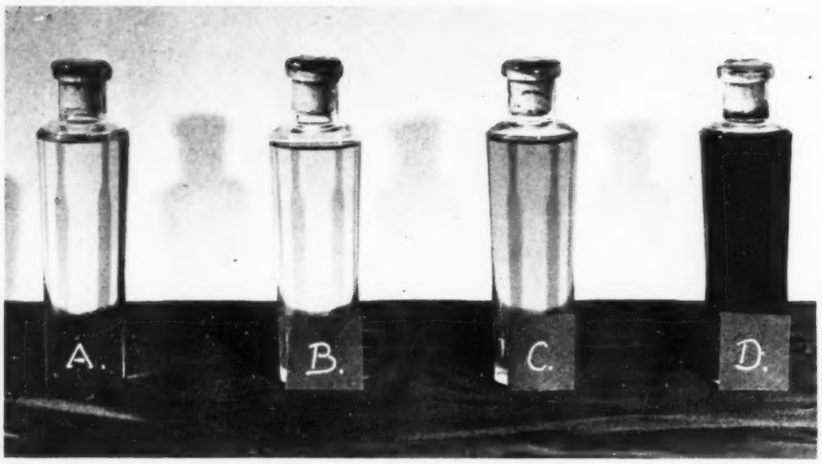

Four samples of absorption oil used in a cycling plant. Sample A is reclaimed oil from oil-reclaiming still; B is lean oil in the system; C is fat oil in the system, and D is a sample of still bottoms in the oil-reclaiming still

perature of the fat oil from the low-pressure vent tank, before entering the exchangers, is 92° F. The temperature of the lean oil from the last fractionating still is 415° F. before entering the heat exchangers. In the shell-and-tube type exchangers in this instance, the lean oil flows around the tubes carrying the fat oil. When the lean oil leaves the exchangers it has been cooled to 112° F. and is then on its way to last cooling process before going to the high-pressure lean oil pumps, which discharge to the absorbers. The fat oil leaving the exchangers has been heated to 301° F. It then goes to a fired heater for further heating, before entering the primary still. The gas-fired heater serves as an "oven", the fat oil being carried through the heater by tubes, entering at the top of the heater and leaving from the bottom. One section of the tubes is in the top of the heater and the other section in the bottom. The burners are in between these sections. The heat is supplied by gas burners using residue gas as fuel. An extremely high temperature is maintained in the heater. The fat oil entering at 301° F. leaves at 540° F. before going to the primary still.

The fat oil enters the still with a temperature higher than the end point of the gasoline desired but lower than the vaporization point of the oil. The distillation range of the gasoline is determined in the still by the top temperature. The higher the end point desired, the higher the top temperature that is carried, which is controlled by reflux. The temperature in the gasoline still must be high enough to release the gasoline fractions from the fat oil, yet not high enough to cause the absorption oil to vaporize. The gasoline in vapor form goes off the top of the still to cooling coils for condensation. The cut on the gasoline vapors is regulated by the reflux, which controls the top temperature of the still. The reflux returns the heavier ends that leave the still with the vapors to the bottom and the light ends not affected by the reflux leave in vapor form.

Agitation by live steam is introduced in the bottom of the still and serves two purposes. It increases the efficiency of separation of the gasoline fractions from the fat oil, and also affects the flash point on the kerosine in the next still. The gasoline fractions go off overhead in vapor form to coolers and then to stabilization units for further control.

After the fat oil is stripped of its gasoline fractions in the primary still, it then goes to a secondary still, where the kerosine fractions are taken in vapor form off the top. It is important that the fat oil be stripped of its kerosine fractions, otherwise its absorptive qualities are impaired when it returns to the absorbers. The usual method of checking the lean oil to ascertain whether it has been stripped is by a laboratory distillation test. The end point of the kerosine is known; therefore, the initial boiling point of the lean oil serves as the indicator. If the lean oil has not been stripped of its condensable fractions the initial boiling point of the lean oil will be considerably lower than the end point of the kerosine. It is desirable to keep the end point of the kerosine and the initial boiling point of the lean oil as close as possible to assure that no light ends are in the lean oil. If the lean oil is not stripped when it returns to the absorbers, its efficiency is reduced, because it does not have the absorptive qualities it would have were it stripped of all the light ends. When the saturation point of the lean oil is reached it cannot absorb any more gas, so it is best to strip it as clean as possible for continued efficiency. The oil then leaves the still as lean oil. It is picked up by a pump and goes to the heat exchangers for cooling by passing countercurrent to the fat oil coming from the low-pressure vent tank, and then to another cooler, where it is picked up by the suction of the high-pressure lean oil pumps and discharged to the absorbers, where it again begins its cycle.

Reclaiming Absorption Oil

Absorption oil cannot be used constantly without being revitalized. A reclaiming oil system is essential. For this purpose a side stream from the lean oil line is diverted to an oil reclaiming still, in which the lean oil is "washed". The heavier hydrocarbons fall to the bottom and are drained off to a burning pit. The amount of residue from this still is negligible. The amount of lean oil taken from the system for reclaiming is not sufficient to keep the still operating and requires the bottoms from the still to be picked up by a pump, passed through a furnace, and returned to the oil reclaiming still. The vapors, being the surplus reclaimed oil from the still, go to a cooler and then to an accumulator where the moisture is removed. The moisture in the oil is picked up from the stripping steam that is introduced into the stills. The oil can be divided into two streams. One stream, used to replace the oil removed from circulation for reclamation, is returned to the system in the lean oil stream going to the heat exchanger, passing countercurrent to the fat oil from the low-pressure vent tank, etc.; the other stream goes to storage tanks.

In plants where absorption oil can be made, the determining factor in regard to the amount made is the top temperature of the kerosine still. The higher the top temperature of the kerosine still, the higher the end point of the kerosine.

It was already mentioned that absorption oil has a narrow boiling range. Its initial boiling point is affected by the end point of the kerosine. The absorption oil end point remains fairly constant because the reclaiming oil still temperature is constant; therefore, a high end point on the kerosine raises the initial boiling point of the absorption oil and decreases the amount of oil recovered. Lowering the end point of the kerosine lowers the initial boiling point of the absorption oil and increases the recovery.

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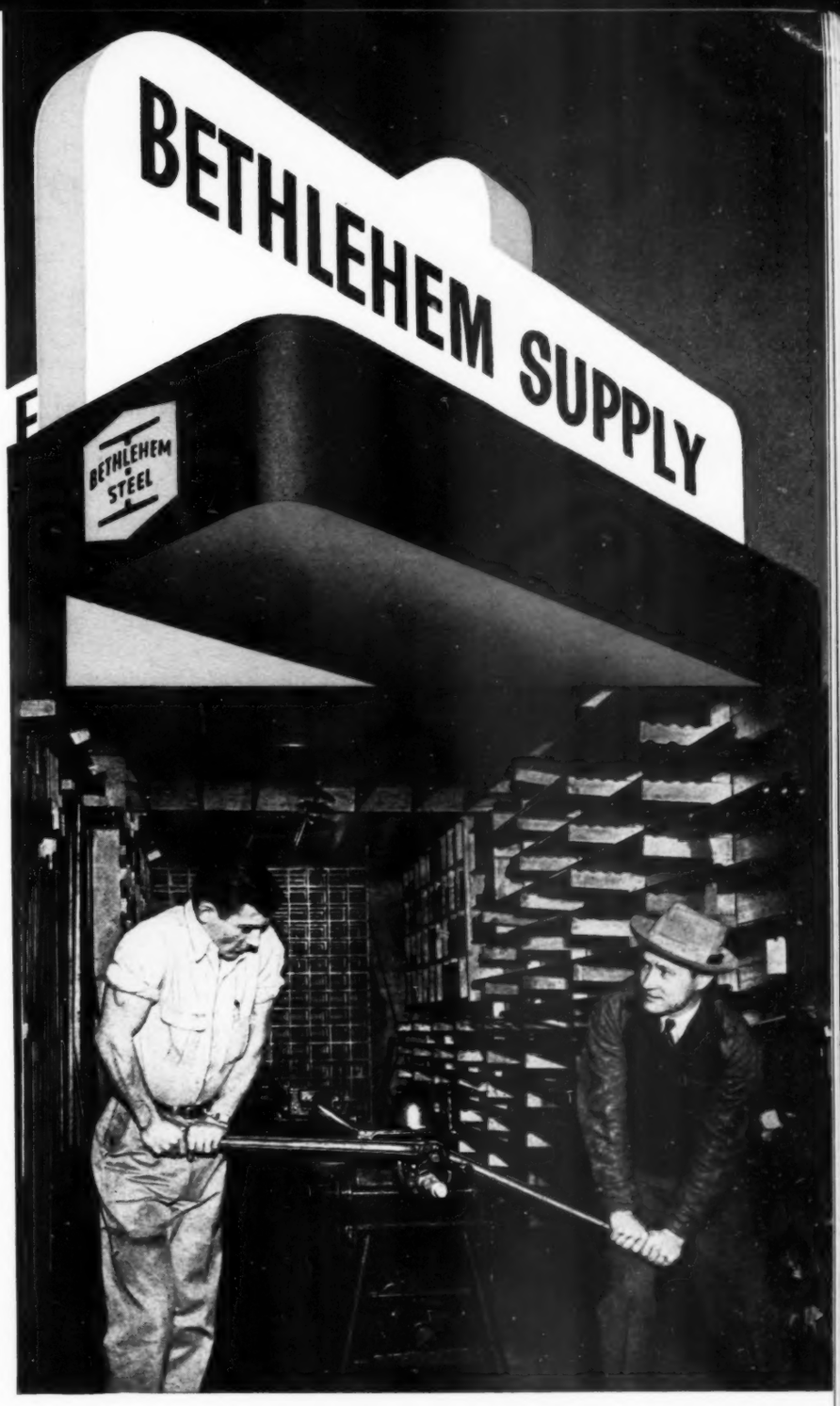

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Gas-Lift Technique Employed In Trinidad Wells

☆ Tubing disk choke aids in solving production problems and in increasing overall efficiency of gas-lift installations

by S. P. King,
Petroleum Engineer, Trinidad Leaseholds, Ltd.

THE tubing disk choke, perhaps the most important innovation in Forest Reserve gas-lift practice during the last year, has solved several local production problems and increased the overall efficiency of many gas-lift installations. The performance of this flexible and economical type of bottom-hole bean has been so satisfactory that it is now a standard item in the majority of wire-line operated surface-controlled installations and in all differential pressure-operated flow valve installations. Before discussing the individual applications of the disk choke, the design now used and the method of computing the orifice size for a given installation, it is perhaps worth while to acquaint the reader with the pertinent geology and general gas-lift techniques of Forest Reserve, Trinidad, British West Indies.

Productive zones may be initially divided into two groups of Middle Miocene sands, namely, the Forest sands and the Cruse sands. They are, generally speaking, loose unconsolidated, fine-grained sands and silts with shale partings. They occur as lenticular sands of varying thickness and lateral extent with oil and water sands frequently alternating with little or no shale break between.

Production Data

Fig. 1 is a typical electrical log of a Forest Reserve well.

The standard completion method is a full-hole cemented combination string of 6⅝-in. 20- and 28-lb. casing, selectively perforated. If sand production is excessive, a pre-packed gravel liner is set opposite the perforations, a cement retainer and lead seal being utilized to obtain a pack-off.

The separate producing sand sections, their variations in thickness, shale condition, and permeability, all result in marked differences of the productivity of each well. The productivity indexes of the wells vary from 0.09 to 0.8 bbl. per day per lb. of differential pressure at the sand face. The average gravity of the crude oil, produced from an average depth of 2680 ft. is 25.7° A.P.I. There is an adequate, economical, and ever-available source of high-pressure gas from the field gas-gathering system, but maximum available pressure at the present time is only 250 lb. per sq. in.

S. P. KING

received a B.E. degree in petroleum engineering from the University of Southern California in June, 1941—At various times previously, mostly during summer vacations, he had worked for the Wilshire Oil Company, Norwalk, California; Royalite Oil Company, Turner Valley field, Alberta, Canada, and Lane-Wells Company in the Turner Valley field and western Canada wildcat areas—Upon completion of his university work he joined the staff of Dowell Incorporated at Turner Valley, later relinquishing that post to accept his present position as petroleum engineer with Trinidad Leaseholds, Ltd., Forest Reserve, British West Indies.

In conjunction with the installations just mentioned, the tubing disk choke is used in wells just past the continuous-flowing stage that flow by heads and for that reason are difficult to pump. All these wells, if not beaned, produce sand and shale and the tubing soon becomes plugged. Surface beaning will curb this plugging to some extent, but sand and shale are still produced and settled out between heads to the extent that standing valves have to be omitted from all installations. Even full-opening flapper check valves are unable to cope with this problem. The plugging agent in all cases is a combination of water sand, fine silt, and clay, and is found in the tubing as solid plugs or ball-like lumps composed of a myriad of individual oölitic-like particles.

Gas-Lift Conditions

A study of the decline curve and the reduction of the bottom-hole pressure per bbl. of oil produced indicates when a well will be due to go on the pump or gas-lift. Wellhead pressure recorder charts, flowing bottom-hole pressure surveys and other investigations designate a well with surging tendencies. Static and flowing bottom-hole pressure surveys are run on the well when in the last stages of flowing, and the bottom-hole pressure, productivity index, static and flowing gradients, and static and working fluid levels are determined. Various rates of oil production are checked against their corresponding quantities of sand produced, downtime, etc. to ascertain the rate of production giving the least trouble. It is dangerous to gas-lift from these unconsolidated formations at too high a rate because of the tendency to sand-up the well. The movement of the sand is due to the velocity of the fluid through the sand, and there is a maximum safe differential pressure to use in producing each well. As daily production and sand face differential determine the productivity index, and the latter can readily be ascertained, it is quite easy to determine the maximum safe differential pressure. Knowing this, it is then possible to design a tubing disk choke that will maintain this differential. When all these factors are determined, a wire-line-operated surface-controlled intermitting unit or a pressure differential controlled flow valve system is designed and installed when the well has ceased flowing.

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Gas-Lift Method

If the latter is decided upon, a tubing disk choke is always included in the design. Inasmuch as these valves operate through the back-pressure existing in the tubing, anything, other than the fluid in the tubing, exerting back-pressure will naturally decrease the amount of fluid lifted and at the same time usually increase the gas-oil ratio. Therefore, if the well is to be beaned to obtain a given rate of trouble-free production, the beaning must be done in such a manner that it creates little or no back-pressure in the tubing opposite the valves. If the well is beaned below the point of injection of the input gas, the back-pressure resulting from beaning is eliminated and the efficiency of the system is improved by utilizing all the available energy in the gas. Because these valves have full opening through the mandrel, an installation of this type can be equipped with a removable bottom-hole choke. Obviously, this type of choke is used whenever available. The Otis removable bottom-hole choke is perhaps the best known of its type.

The surface-controlled wire-line installation, because of the type of valve used, cannot be equipped with a removable bottom-hole choke of the type mentioned. Formerly, if bottom-hole beaning was resorted to, the only available method was the fixed type of bottom-hole bean, which required a pulling job to vary orifice size or effect its removal. The tubing disk choke, however, can overcome both of these difficulties, giving the operator the option of removal or variation in orifice size without necessitating a tubing job.

The essential function of the tubing disk choke is to regulate the rate of flow of oil into the tubing. The necessity for regulation may, however, have its source in various problems. Throughout this article mention is frequently made of trouble-free production, and of daily production resulting in a minimum of downtime. Experience has indicated that decrease in downtime obtained on a restricted rate of flow results in a considerable increase in monthly production over a wide-open rate of flow with its inherent increased downtime. Equipment and replacement shortages, due to priorities and marine transportation difficulties, have necessitated a policy of assigning equipment and servicing facilities to wells giving greatest daily production. It can readily be understood then why minimum downtime is more or less the criterion of efficient gas-lift installations in Forest Reserve.

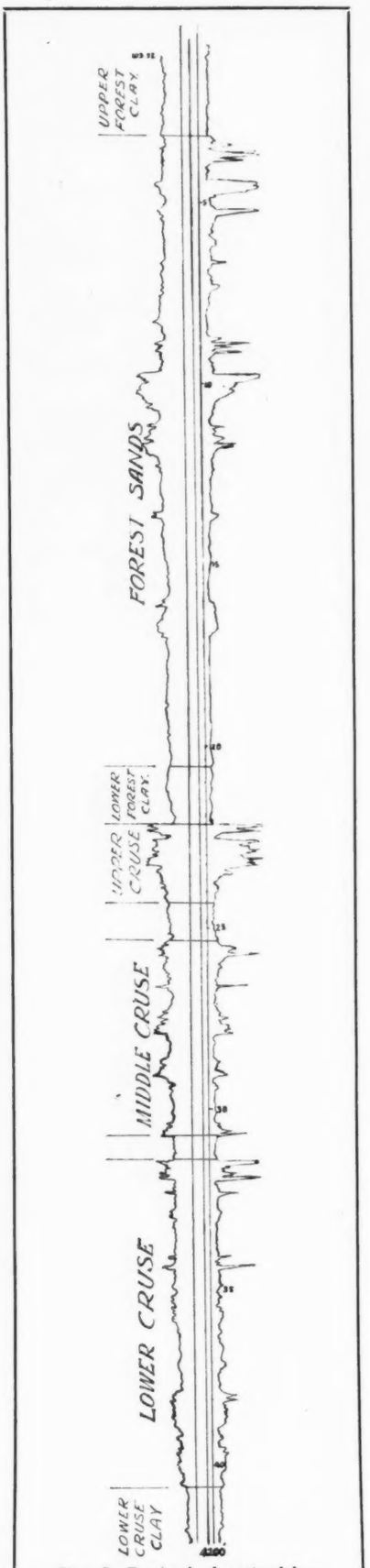

Fig. 1. Typical electrical log of a Forest Reserve well

Application of Tubing Disk Choke

The first application of the tubing disk choke is to produce a well to a predetermined daily quota that the operator believes will result in a minimum of downtime.

In open-system intermitting installations tubing disk chokes have corrected the tendency of the annular fluid level to lower every time a "slug" of oil is lifted in the tubing. Thus a constant fluid level, which is often required as back-pressure against the formation, can be maintained. The tubing disk choke imposes a rate of fill-up in the tubing that is equal to or slightly less than the productive capacity of the formation. In this manner, equilibrium between tubing and annulus is re-established by the inrush of oil from the formation rather than from the annulus, leaving the working fluid level in the casing more or less constant.

Occasionally high gas-oil ratios may be reduced to a normal value by substituting a tubing disk choke in place of a surface bean. From the viewpoint of efficiency, the bottom-hole bean is the ideal method of back-pressuring this type of gas-lift installation.

The surging tendency of the wells is usually corrected by installing a disk choke. Perhaps because of this or because the velocity in the lower end of the tubing is considerably reduced, wells that formerly were consistently becoming plugged gave no more trouble after being equipped with disk chokes. This application is perhaps the most important from the viewpoint of decreasing downtime.

Determining Size of Disk

To determine the correct size of disk choke for a particular installation, it is necessary to have the following well information: first, static bottom-hole pressure must be known; second, productivity index should also be known; third, desired daily rate of production must be decided upon; fourth, estimated working fluid level with available working casing pressure must be ascertained.

The method can perhaps be best illustrated and more readily understood by a concrete example. Let us assume the static and flowing bottom-hole pressure survey has been run, and the results tabulated and graphically plotted as in Fig. 2.

Assuming the productivity index is a constant with rate of production at low rates of flow, we can compute the flowing bottom-hole pressure for any daily production. Let us say the records indicate that a production of 100 bbl. per day is the most trouble-free rate. From

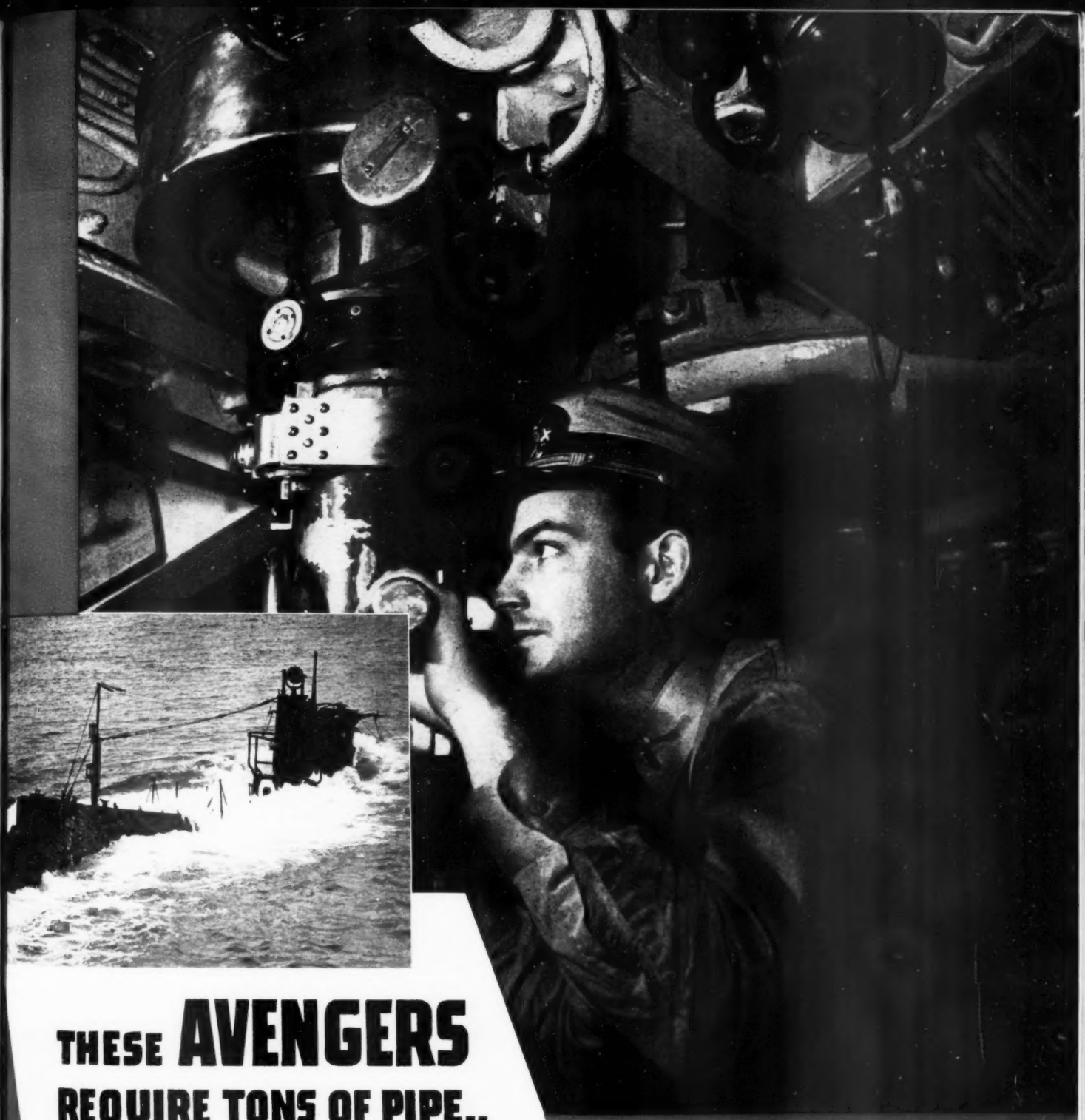

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Fig. 2 we have the productivity index and the bottom-hole pressure. The calculation then, substituting in the productivity index formula, is:

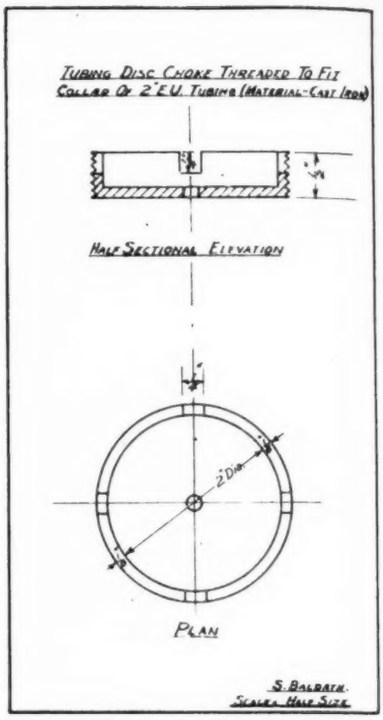
$$0.192 = \frac{100}{1180 - \text{flowing bottom-hole pressure at 2300 ft.}}$$

(Note that the pressures are taken at 2300 ft. as this will be the location of the tubing disk choke.)

The flowing bottom-hole pressure of 659 lb. per sq. in. at 2300 ft. is the effective upward pressure at that point. Exerting a back-pressure against this effective bottom-hole pressure is the column of fluid above the disk choke. At present this is calculated on the basis of a static column, inasmuch as the back-pressure exerted by a moving vertical column involves very complicated computations using formulae that have not definitely been proved correct. The errors so introduced are not effectively great when the daily rate of flow is less than 200 bbl., however.

The fluid column above the disk is divided into two parts: one being a constant column from the operating valve to the disk, the other being a fluctuating column that represents the fluid build-up from the time of fluid ejection until the weight bar is again raised, opening the valve. The average back-pressure exerted by the column above the valve is approximately one-half the working casing pressure. Immediately after the ejection of a "slug", the pressure at the operating valve is probably very near to zero. When the valve is opened the back-pressure exerted against the effective bottom-hole pressure is the working casing pressure. As the "build-up" in the tubing past the valve should be a very nearly constant rate, the average of the maxima and minima over a period of time and neglecting the short interval spent in ejecting the fluid "slugs" would, in our example, be 125 lb. per sq. in.

The back-pressure exerted by the column of fluid between the valve and the disk is the product of the distance in feet times the weight per foot of the well fluid. To evaluate the distance factor, it is necessary to determine which valve will be operative when the well is put on steady production. A rule of thumb measure is used and experience has proved it fairly accurate.


Tubing Disc Choke Threaded To Fit Collar Of 2" E.U. Tubing (Material-Cast Iron)
Half Sectional Elevation
2 Dia.
Plan
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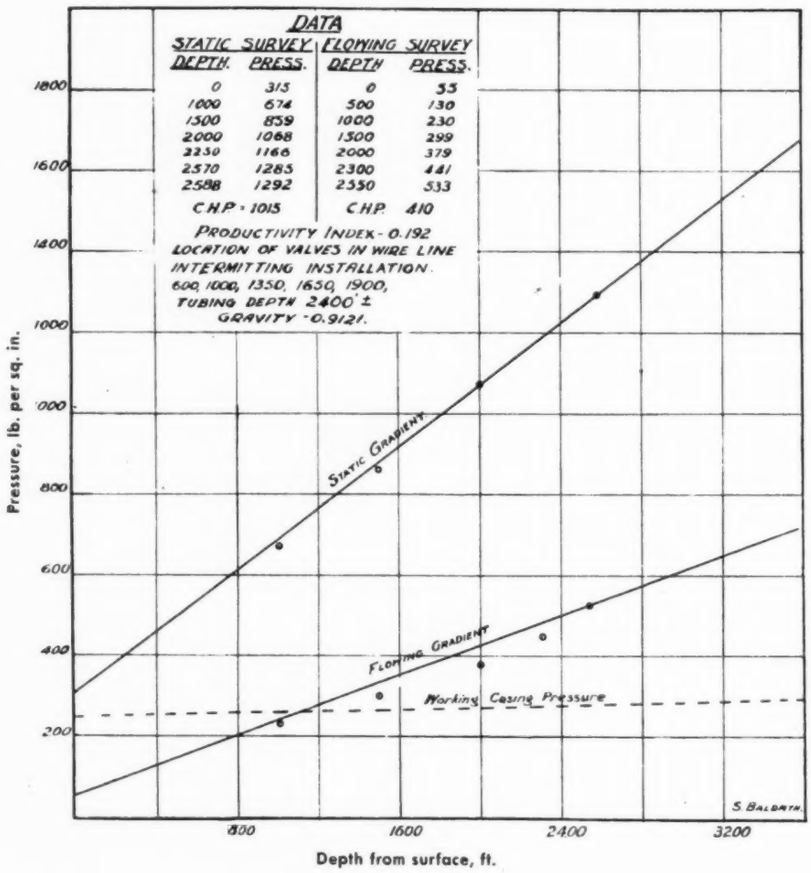
Scale Half Size

Fig. 3. Diagram of type of tubing disk used in Forest Reserve wells

Fig. 2. Results of static and flowing bottom-hole pressure survey plotted graphically



Calculations

In Fig. 2, a casing pressure gradient is drawn intersecting the flowing gradient. It is assumed that the working fluid level in the annulus will be in the vicinity of this depth. Thus, we use the valve immediately below this intersection for our computations. The casing pressure gradient is calculated from E. O. Bennett's formula:

$$P = P_t\,(1 + 0.0000361 \times L \times G)$$

Where:

P = absolute pressure at the bottom,
P_t = absolute pressure at the top,
L = the length in feet of the gas column, and
G = the specific gravity of the gas.

The evaluation of the back-pressure exerted by the column of fluid above the valve in our example is:

$$125 + 0.434 \times 0.92$$
$$(2300 - 1350) = 504$$

The pressure differential across the tubing disk choke is 659 — 504 or 155 lb. per sq. in.

The problem is now resolved into one of flow of fluids through an orifice and the following formula is based upon the fluid being water with a specific gravity of 1.0. The formula for such flow is:

$$d = \sqrt{\frac{0.001485\,Q}{K\sqrt{\frac{P}{0.434}}}}$$

Where:

Q = flow, in bbl. per day,
d = diameter of orifice, in.,
P = pressure across orifice, lb. per sq. in., and
K = orifice constant,
= 0.60 for sharp edged orifice.

The above equation is then the theoretical orifice size to produce a given quantity of water for a given pressure differential across the orifice and is suitable for liquids having a viscosity and specific gravity equivalent to water at its greatest density (39.2°F.).

As liquids in an oil well seldom have a viscosity and specific gravity equal to water, a correction factor must be introduced. As no data are at hand concerning the flow of fluids having a viscosity and specific gravity other than water, an empirical correction factor has been used ranging from 0.8 to 0.6. For instance, in the East Texas field, where the viscosity of the crude is approximately 40 Saybolt Seconds Universal, which compares with 31.5 Saybolt Seconds Universal for water, the correction factor used is 0.80, making K = 0.48 in the foregoing formula. Generally the viscosity correction factor will have to be based on the type of fluid being lifted and should vary some 0.6 to 0.8, depending upon its viscosity. Value of K most generally applicable for Forest Reserve crude oil is 0.45.

Substituting our example values in the formula, we derive a disk choke size of 4/32 in. Anticipating future decline in bottom-hole pressure conditions, a 9/64- and 5/32-in. disk choke are also included in the installation. The individual disks are installed increasing the orifice size from the top downward, spacing the disks one "single" apart. When production records indicate that the top disk is too restrictive, it can be broken-out by the weight bar, and produced from the well. In a similar manner, the next disk may be broken-out when it too becomes too restrictive and the well produced through the remaining disk.

The type of tubing disk now used (see Fig. 3) is a positively placed type that screws well down into the upset collar of the tubing string at the desired depth. The threads on the disk are cut very full so that they can adjust themselves to the taper of the upset collar and can be screwed far enough down with a setting tool to allow at least 1¼ in. of the pipe's threads to be engaged before it shoulders on top of the disk.

Acknowledgment

Grateful acknowledgment is made to E. D. Wilde of The Guiberson Corporation for his detailed correspondence on orifice size and for the formula included in this report. The writer wishes also to express his thanks to E. Gransaull and P. L. May of Trinidad Leaseholds, Ltd., Production Department, for their assistance in designing and testing these chokes.

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P 094.6

Extending Life of Multiple V-Belt Drives

As a contribution to the rubber conservation program, and having as its purpose the education of power users in the proper procedure of selection, installation, and maintenance of multiple V-belt drives to obtain maximum life of V-belts, the Engineering Research Bureau of the Multiple V-Belt Drive Association has issued suggestions to aid in attaining this end. A part of these suggestions follow:

Avoid underbelting a drive. Underbelting a drive is a wasteful practice. Experience has shown that using 4 belts instead of 5 will result in a reduction in V-belt life of approximately 60 percent. On the basis of 10 belts being the normal requirement, adding one belt will increase the life of all the belts in the drive by 40 percent, whereas removing one belt will result in a decrease of 35 percent in belt life. In other words, 10 percent overbelting will show a 40 percent gain in belt life, whereas 10 percent underbelting results in a 35 percent loss.

Employ larger pulleys. Don't make the mistake of using pulleys too small in diameter. Sheaves, smaller than recommended size, result in unnecessary V-belt tension and bending, causing overheating and break-down of the belt structure. Larger sheaves greatly increase belt life expectancy. Larger sheaves also permit use of fewer belts.

V-belts should not exceed recommended speeds. V-belt and sheave combinations have different critical speeds at which centrifugal force tends to throw the V-belts away from the sheave grooves. Operating a drive with the belt traveling above the recommended f.p.m. causes a considerable loss in hp. per belt. Increasing the belt tension to overcome centrifugal force reduces the belt life, a wasteful practice. To insure efficient operation consult manufacturer's catalog for belt speed recommendations.

Properly position motor for belt slack takeup. The motor should be positioned during installation so that approximately one-fifth of the total available movement is toward the driven unit, permitting easy V-belt application. In this way remaining belt movement is available for take-up purposes. Another method is to place the motor so that available movement between driver and driven pulleys is slightly in excess of the thickness of the V-belt.

Don't pry V-belts over sheave rim; roll them on by hand. Using a bar may rupture the belt structure and cause short life.

Have V-belt slack equal. A set of belts should be carefully placed in the grooves by hand so that the slack of all belts is on either the top or the bottom.

V-belt tension must be uniform. When a drive is idle, V-belts will appear snug in sheaves. A slight sag can be detected on the loose side of the drive when it is in motion. Unless new belts are taken up after a 48-hour "running in" period, belt damage may result due to heat caused by slippage.

Sheave and shaft alignment must be correct. Shafts and sheave grooves should always be in proper alignment; otherwise side wear on V-belt will take place.

Guard for drives should be well ventilated. Guards for drives are recommended to insure safety and cleanliness. Provision must be made for adequate circulation of air, permitting the escape of developed heat, which is injurious to belts.

Sheaves should be firmly keyed on shaft. Loose sheaves that slide out of alignment with pulley cause V-belts to operate in an unnatural condition, which results in damaging side wear.

Don't overload primary V-belt drives. Primary drives are usually installed to handle a specific load. Adding secondary drives that increase the load will greatly shorten the life of the belts on the primary drive.

Do not install drive alongside radiator. When they are subjected to operating temperatures of over 140°F. the rubber will become hard and brittle due to "overcuring," resulting in premature cracking and breakage.

Always use matched sets of belts. All V-belts made for multiple V-belt drives are coded or marked with definite length ranges. Longer life is assured by installing belts in matched sets.

Don't use belt dressing. If slippage is evident, eliminate the cause by applying belt tension. Belt dressing should not be used, as it is injurious.

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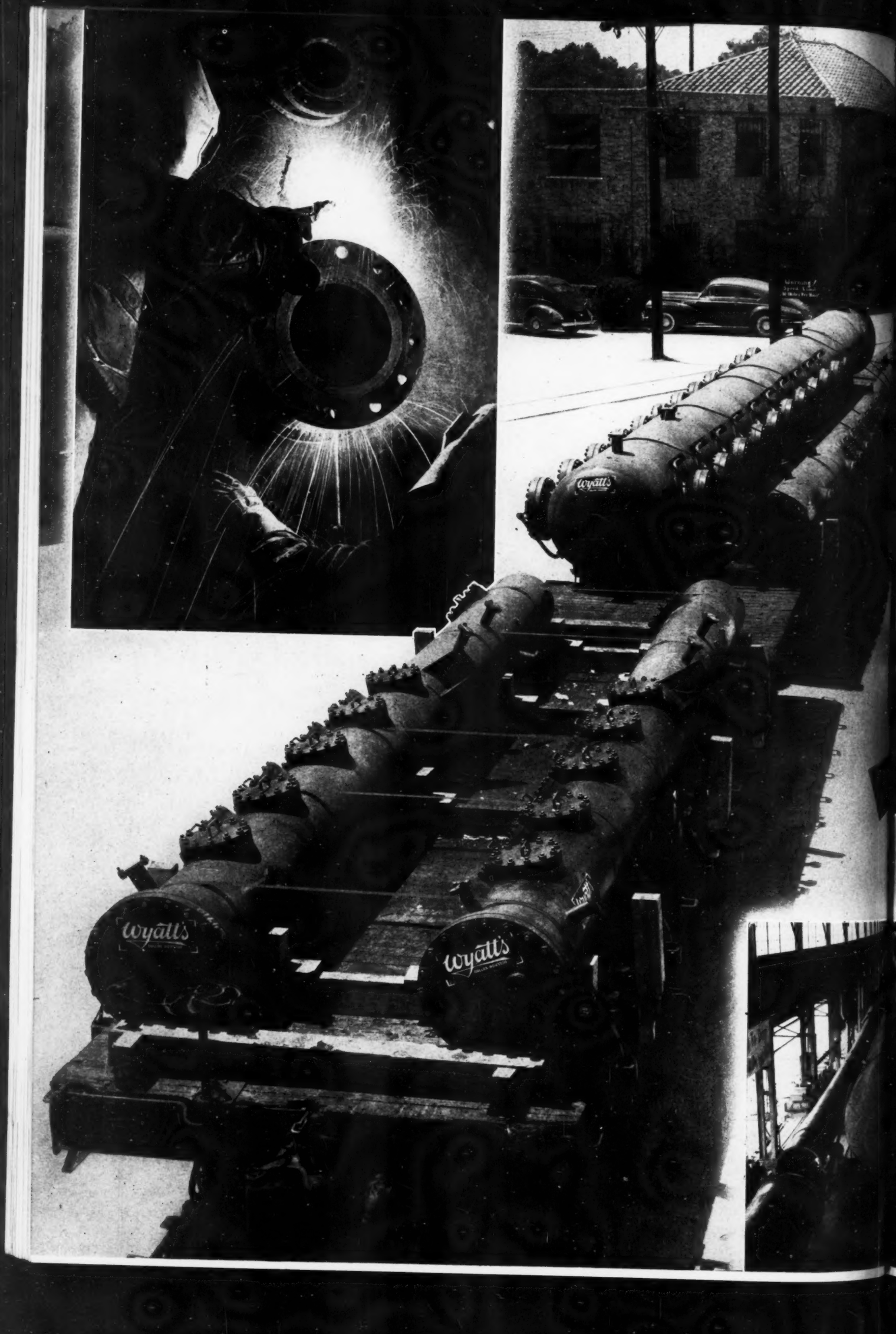
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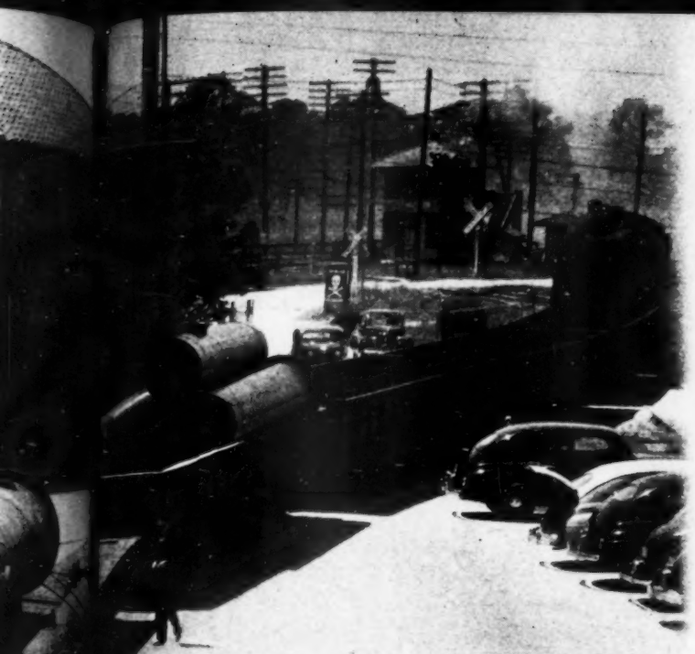

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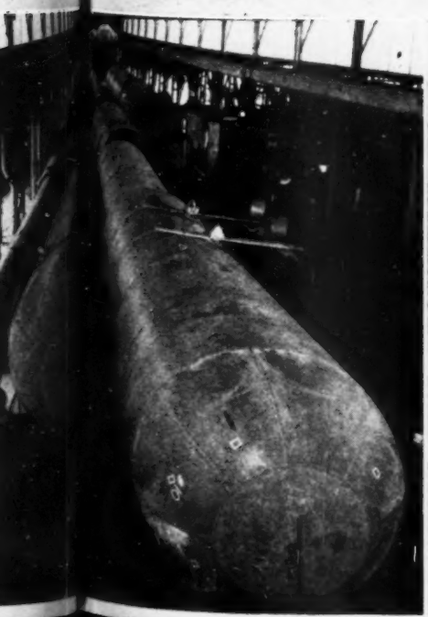

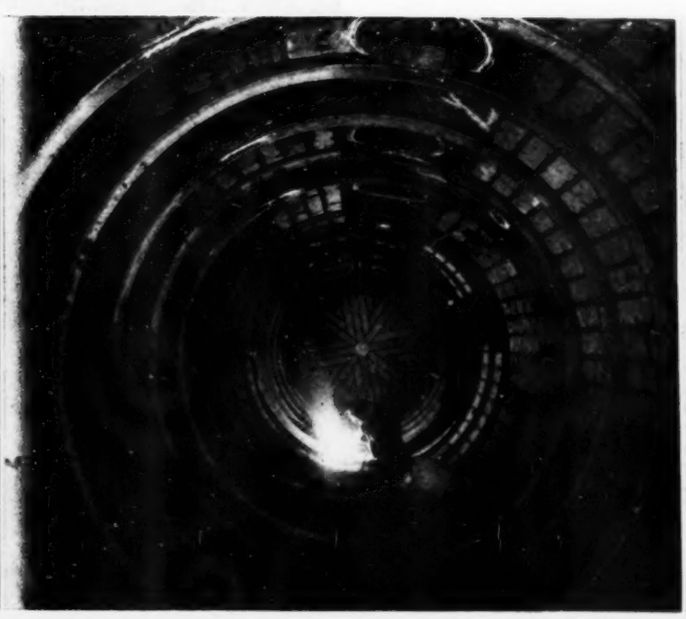

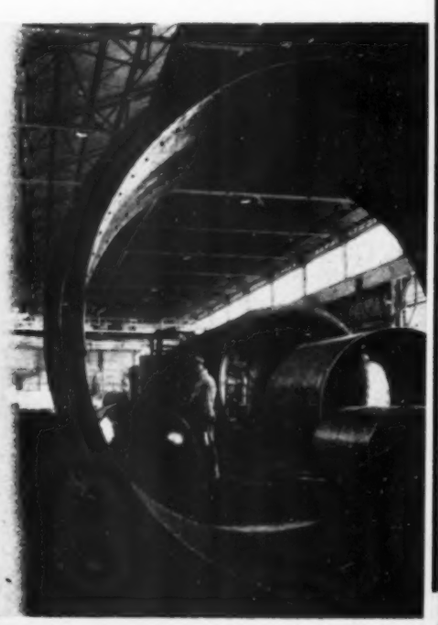

The Value of Gasoline For Gas-Making Purposes

☆ Results of operating tests supplement data obtained in the laboratory

by W. H. Ganley, Falley Petroleum Company
and
R. W. Stafford, Connelly Iron Sponge and Governor Company

W. H. GANLEY

THE results of a preliminary investigation made upon a request of the Chicago Office of Petroleum Coordinator to determine the value of gasoline for gas-making purposes indicated that it could successfully be used.[1] This preliminary report was based on data obtained in the laboratory.

Data presented in the present report cover the results of operating tests made at the Fond du Lac plant of the Wisconsin Power and Light Company on September 2, 1942.

The water gas machine was a Semet-Solvay 8-ft. reverse flow type installed in 1938. Forty-two courses of checker brick, 88 bricks per course, were contained in the superheater. The bricks were staggered with 2 in. spacing. The carburetor contained no checker brick.

A Viking rotary pump direct-connected to an electric motor that operates only when the oil is being introduced supplied the oil. The oil was metered through a National meter and introduced into the top of the carburetor through an Anthony spray. Normally the oil is preheated ahead of the meter. When introducing gasoline the oil preheater was bypassed and the pressure was reduced to 45 lb. The gasoline temperature was 75° F. This plant's oil lines have both threaded and welded joints.

The oil line from the tank truck to the machine and the oil pump were frequently inspected for leaks. Only one small leak developed, this being at the top of the carburetor where the oil line was connected to the oil spray. As the gasoline was used directly from a truck tank, no information was developed regarding possible hazards of storing gasoline in existing gas oil storage tanks.

A pyrometer installed in the top of the superheater, which on this type of machine corresponds to the base of the superheater on a standard three-shell set, was connected to a Leeds and Northrup recorder.

Both air and steam meters and a U.G.I. automatic control were part of the equipment. The B.t.u. content of the gas made was determined and recorded with a late model Thomas recording calorimeter.

Test Run

The machine was operated for about an hour and a half with the fuel oil normally used. A switch was then made to gasoline without any changes in operation other than bypassing the oil preheater.

The generator fuel was 100 percent coal, 1200 lb. being charged every 12 runs. The coal used was a 5 by 2 Fleming Elkhorn containing about 3½ percent ash.

During the period of the test, 10.6 hours, 1965 gal. of gasoline were used.

R. W. STAFFORD

The fuel bed in the generator was cleaned or clinkered the morning of the day before the test run. Normal practice at Fond du Lac is to clean the fuel bed after 40 hours operation. As the machine is operated between 10 and 12 hours per day, the fuel bed is cleaned about twice a week.

The temperature at the top of the superheater was 1450° F. at the beginning of the test. Fourteen gallons of gasoline were used per run, however, this quantity was reduced to 11 gal. after two hours because of an increase in the B.t.u. content of the gas. At the same time the temperature was lowered to 1400° F. Operations were continued at this temperature for two hours and then temperatures were raised 50° at a time over a 2½-hour period until 1650° F. was reached. After a small amount of lamp black appeared in the washbox overflow and qualitative tests showed naphthalene present, the temperatures were reduced to 1450° F. and held there during the last two hours of the test period.

[1] "The Value of Raw Gasoline for Gas-Making Purposes," by W. H. Ganley and R. W. Stafford, *The Petroleum Engineer*, October, 1942.

In WAR or PEACE it's Vogt for better HEAT TRANSFER EQUIPMENT

1. Heat Exchangers in the foreground have monel metal shells, admiralty metal tubes and naval bronze tube sheets, floating head covers, and baffles. Vogt Ell Bolts are used on floating head covers.
2. Reactors for catalytic polymerization units being assembled and tested. Each is of welded construction and has bolted-on hinged covers.
3. Group of Diesel Oil Exchangers for a visbreaker. Used to exchange heat between diesel oil and corrosive crude containing salt and sulphur compounds.
4. 62"x30'-6" long Gas Cooler for a catalytic unit in a large refinery. Tube bundle at right is for a second unit.

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The operating cycle used was as follows:

	Seconds	
Blast	45	Total generator air — 3400 cu. ft.
Blowrun	7	Total generator air — 450 cu. ft.
Uprun	99	30 lb. steam per min.
Backrun	52	75 lb. steam per min.
Final uprun	7	30 lb. steam per min.
Air purge	7	
Total cycle	217	

The following is a comparison of results obtained with gasoline and those obtained with other enriching agents normally used at the Fond du Lac plant:

	Gasoline	Crude oil	Fuel oil
B.t.u. of finished gas	519	522	522
Fuel-lb. per M. cu. ft.	22.2	22.1	22.5
Oil-gal. per M. cu. ft.	2.60	3.04	2.93
Make per hour—M. cu. ft.	71.2	78.8	79.5
Make per run—cu. ft.	4900	5434	5480
Steam—lb. per M. cu. ft.	24.2	21.8	21.6
Generator air—cu. ft. per M. cu. ft.	785	710	703
Cu. ft. air per lb. steam	32.4	32.5	32.5
Percent backrun steam	55	55	55
B.t.u. contributed to gas per gal.	116,000	100,000	103,000
Cu. ft. oil gas per gal.	75.0	67.5	70.5
B.t.u. per cu. ft. oil gas	1550	1480	1460
H_2S grains per 100 cu. ft.	70	140*	100

*This oil contained 2½ percent sulphur.

These figures do not reflect the most efficient operation with gasoline because of changes in operation during the day, made in order to determine the effect of various cracking temperatures. The results shown on the other two enriching agents represent operating figures recorded over 30-day periods.

Trowel tests and observations of the washbox overflow indicated that the best cracking temperature for gasoline is about 1450° F. in this particular machine. At 1550 and 1600° F. a small amount of lampblack appeared in the washbox overflow. At 1400 to 1450° F. the naphthalene test showed none present. At 1500 to 1550° F. the test showed considerable naphthalene.

During this test the time of contact on this machine was 15 seconds, whereas with a standard three-shell machine it will average about 5 seconds. Due to this difference in time of contact, a higher temperature will probably be required with a standard machine, which has checker brick in both the carburetor and superheater.

The make per hour was lower with gasoline than with the crude oil and fuel oil. For the first four hours of the test, the average make per hour was 78.5 M. cu. ft. During this period the temperature was about 1450° F. The higher temperatures (1500-1650°) required longer blast periods, which increased the length of the cycle and reduced the number of cycles per hour. During the first four hours of the test period, the runs per hour averaged 17.5 and the make per run 4474 cu. ft. For the rest of the test period, the runs per hour averaged 12.4 and the make per run 5320 cu. ft., or 66.2 M. cu. ft per hour. If the temperature carried during the first four hours had been maintained throughout the entire test period, the average make per hour would undoubtedly have been between 75 and 80 M. cu. ft.

Although it was not possible to determine the amount of tar produced with gasoline, observations of the washbox overflow indicated that the tar production is considerably less than that produced with the crude oil.

Results of Tests

The results of tests and analyses of gas samples (Table 1) show actual analyses of samples taken during test operation. During these tests samples of all the backrun blue gases, uprun blue gases, and blast gases were collected in gas bags. They also show analysis of sample taken from outlet of storage holder before the use of gasoline was begun. This represents the gas made under normal operations using crude oil.

In Test No. 1, these gases represent composite samples taken between the 33rd and 45th runs on gasoline and between the 5th and 6th coaling of the day's run. There were 12 runs during this period. In Test No. 2, these gases represent composite samples taken between the 93rd and 105th runs on gasoline and between the 10th and 11th coaling of the day's run. There were 12 runs during this period.

These sets of samples were taken from the machine as follows:

Blast gases taken from top of generator during the blast period.

Uprun blue gas taken from top of generator during the uprun period.

Backrun blue gas taken from backrun pipe during the backrun period.

Two samples were taken at the outlet of the purifiers. One sample was taken about three hours after the test began; the other was taken four hours later. These samples represented the finished gas made with gasoline.

All gas analyses were made by the U. S. Bureau of Mines Gas Analyzer over mercury and are reported in percent by volume.

Hydrogen sulphide tests were made by means of the Tutweiler Burette.

Specific gravity tests were made by the Schilling gas density apparatus.

The naphthalene tests were made by passing the gas through picric acid solution and observing the presence or absence of a precipitate. This test was only qualitative.

The heating values of the gas produced were taken from a Thomas Calorimeter chart.

For purposes of comparison the composition of the combined uprun and backrun blue gas was calculated as follows:

As 55 percent of the total steam used per run was used on the backrun, it was assumed that 55 percent of the total blue gas made per run was made on the backrun and 45 percent on the uprun. The composition of the combined uprun and backrun blue gas was calculated by taking 45 percent of the constituents of the uprun blue gas and adding it to 55 percent of the constituents of the backrun blue gas. This was done with the blue gas analyses of Tests 1 and 2 and the results of the two tests were averaged. An average was also made of the blast gas analyses of both tests. The calculated average composition of the total blue gas made, blast gases, and finished gas is as follows:

Sample	Blast gas	Blue gas	Finished gas
Carbon dioxide	13.7	4.5	5.3
Illuminants	0.1	0.4	9.3
Oxygen	0.8	0.8	0.4
Carbon monoxide	8.8	30.4	22.3
Hydrogen	3.4	52.0	31.1
Methane	0.4	3.5	10.4
Ethane	—	—	2.0
Nitrogen	72.8	8.4	19.2
Total	100.0	100.0	100.0
B.t.u. calculated	43	305	519

The cu. ft. of blast gas made per cu. ft. of generator air was calculated by dividing the nitrogen in the blast gases into the nitrogen in air (79 percent). This gave 1.085. The average amount of generator air used per blowrun was 450 cu. ft., which produced 488 cu. ft. of blowrun gas per run. This was 10 percent of the total average gas made per run.

The percentage of blue gas in the finished gas was calculated from the percentage of carbon monoxide in the blue gas and the finished gas. The carbon monoxide content of the finished gas was corrected for the carbon monoxide in the blowrun gas. This correction was made by deducting 10 percent

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of the carbon monoxide in the blowrun gas (blast gas) from the percentage of carbon monoxide in the finished gas and gave the percent of carbon monoxide in the finished gas due to the blue gas. The percentage of blue gas in the finished gas was calculated by dividing the percent of carbon monoxide in the blue gas into the percent of carbon monoxide in the finished gas. Percent oil gas in the finished gas was taken as the difference between 100 and the combined blue gas and blowrun gas. (Blue gas includes whatever coal gas was recovered from the coal used for generator fuel.)

Assuming the same composition for the blue gas and blowrun gas with normal operation using crude oil and fuel oil, the finished gas was calculated to contain the following:

	Gasoline	*Crude oil*	*Fuel oil*
Percent blowrun gas	10.0	9.0	8.9
Percent blue gas	70.5	70.5	70.5
Percent oil gas	19.5	20.5	20.6
B.t.u. due to oil gas	301.5	303.0	303.0

From these results and the oil used per M. cu. ft., the B.t.u. per gal. cu. ft. of oil gas made per gal., and the B.t.u. per cu. ft. of oil gas were calculated.

Based on gasoline containing 123,000 B.t.u. per gal., a cracking efficiency of 94 percent was obtained by calculation. This compares with a cracking efficiency of 70 percent with the oils normally used.

Due to the use of coal and blowrun, the Pacific Coast Method of calculating oil efficiencies could not be used. As carbon monoxide is a product of the blue gas reaction and is not formed by any cracking as is hydrogen, the method used for calculating oil efficiency was considered the best.

Summary

Briefly, the above data indicate the following:

1. Raw gasoline can be successfully gasified in a carburetted water gas machine.

2. These tests indicated a cracking temperature of about 1450° F. as the best for Fond du Lac. It is believed that with a standard three-shell machine a higher temperature will be required. For any given machine, the proper temperature should be determined experimentally.

3. The set capacity is approximately the same with gasoline as with the oils normally used in the manufacture of carburetted water gas.

4. Higher fuel cracking efficiencies can be obtained by the use of gasoline.

5. The tar produced from gasoline is materially less than from the oils normally used.

6. The main problem in the use of gasoline is handling and storage, including state and local regulations.

7. With the present price and tax structure, it is not economical to use gasoline. Action should be begun to have the 1½ cents Federal tax law changed so that it will not apply on gasoline used for gas making purposes, as it would be used to release fuel oils and gas oils that are badly needed by war industries unable to convert to gasoline.

Based on current costs of gasoline, the Fond du Lac test, including Federal tax, was slightly more than 8 cents per M. cu. ft. in excess of costs using fuel oil at present market price. This is exclusive of tar credits, which would increase the differential still more.

Acknowledgment

The writers wish to express their appreciation to R. G. Walter, assistant to executive vice-president, Wisconsin Power and Light Company, Madison, Wisconsin, for granting permission to make the test run and to the following men who were present or otherwise contributed toward the presentation of this information:

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S. Cohn, senior chemist, The Peoples Gas Light and Coke Company, Chicago, Illinois.

C. F. Cramer, superintendent, Manufactured Gas Department, Ohio Fuel Gas Company, Toledo, Ohio.

John Dopp, superintendent of gas plant, Wisconsin Power and Light Company, Fond du Lac, Wisconsin.

L. J. Eck, vice-president, Minneapolis Gas Light Company, Minneapolis, Minnesota.

S. J. Modzikowski, chemical engineer, The Peoples Gas Light and Coke Company, Chicago, Illinois.

H. E. Sweet, gas engineer, Wisconsin Power and Light Company, Madison, Wisconsin.

L. J. Willien, gas engineer, Public Utility Engineering and Service Corporation, Chicago, Illinois.

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TABLE I

Results of tests and analyses of gas samples

Enriching medium	Crude oil	Test No. 1—Gasoline used as enriching medium				Test No. 2—Gasoline used as enriching medium				
Method of sampling	Snap sample	Composite sample of gases taken between 33rd and 45th runs on gasoline and between 5th and 6th coaling of day's run—total of 12 runs			Snap sample	Composite sample of gases taken between 93rd and 105th runs on gasoline and between 10th and 11th coaling of day's run—total of 12 runs			Snap sample	Average of finished gas samples, Test No 1 and No. 2
Sampling point	Sendout line	Top of generator		Backrun pipe	Outlet of purifiers	Top of generator		Backrun pipe	Outlet of purifiers	
Kind of gas	Regular city gas	Uprun blue gas	Blast gas	Backrun blue gas	Finished gas	Uprun blue gas	Blast gas	Backrun blue gas	Finished gas	
Carbon dioxide	5.6	3.4	14.0	4.8	5.4	4.2	13.4	5.6	5.2	5.3
Illuminants	8.8	0.8	0.0	0.4	10.0	0.4	0.1	0.2	8.6	9.3
Oxygen	0.6	1.0	1.2	0.8	0.2	0.4	0.4	1.0	0.6	0.4
Carbon monoxide	22.2	34.6	8.2	26.0	22.0	38.0	9.4	25.0	22.6	22.3
Hydrogen	30.4	45.8	3.2	58.4	30.2	41.7	3.6	59.6	32.0	31.1
Methane	13.2	2.6	0.3	4.1	10.6	3.3	0.5	3.6	10.1	10.4
Ethane	1.2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	1.9	2.0
Nitrogen	18.0	11.8	73.1	5.5	19.6	12.0	72.6	5.0	19.0	19.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
B.t.u. per cu. ft. of gas—Thomas Calorimeter	518				526				515	519[1]
B.t.u. calculated		297.	39.	317.		294	46.	309		
Specific gravity (air=1)	0.690				0.702				0.670	0.685
Hydrogen sulphide grains per 100 cu. ft. of gas—at inlet to purifiers	140				60				80	70
Naphthalene—at outlet of purifiers					No precipitate				Precipitate formed	....

NOTE: Analyses reported in percent by volume

[1]Average of 26 readings from Thomas calorimeter chart over entire period of test.

The Controlled Materials Plan

☆ Allotments and schedules co-ordinated in keeping with supply of raw materials available

THE Controlled Materials Plan gets its name from the control that is applied to the three metals, steel, copper, and aluminum, which are specifically allocated under its terms. It is believed that if production is controlled in terms of these three metals the distribution of other metals will be relatively simple. It may develop that some other materials will have to be brought under similar control; but of the materials widely used for production, steel, copper, and aluminum are believed, at the present time, to show the greatest shortage relative to demand.

Control of material, however, is really only one-half of the job undertaken by the new plan. The other, and perhaps more important half, might be called "Controlled Schedules." Schedules are to be limited to the material available as a condition of the allotment; thus schedules will be controlled not only on the basis of what is wanted, as heretofore, but also in terms of what can be realized from the raw materials available.

The Controlled Materials Plan ties together the control of material and the control of schedules through the simple procedure of making raw material allotments through the same channels followed in setting the production schedules. For example, the Army sets the production schedules for the prime contractors for tanks; under CMP the Army will also allot the material to the prime contractor of tanks, who in turn will re-allot it to his sub-contractors, also setting production schedules for his sub-contractors. If it becomes necessary to cut the amount of material available for the production of tanks, the Army will reduce the production schedules of the prime contractor, and at the same time, reduce the amount of the material to be made available. The prime contractor will go through the same steps with his sub-contractor.

This process, called vertical allocation, differs from the previous system in that, under PRP, the War Production Board issued the authorizations to the manufacturers regarding the amount of material they were permitted to procure, whereas the Army, Navy, and other agencies issued instructions regarding the production schedules to be maintainecd. It was often not possible to insure co-ordination, and the manufacturer was faced with a conflict between production schedules and material authorizations that he could not resolve.

The Controlled Materials Plan —CMP— is becoming a new way of life for the majority of United States manufacturers. It is important to the war effort and to industry that everyone using the basic and critical materials, steel, copper, and aluminum, understand CMP as it applies to his operations.

The accompanying article, prepared at the direction of Chairman Donald M. Nelson, outlines the technical details of CMP and the steps that should be taken by industry and the governmental agencies handling materials and production programs and schedules.

Definitions

To understand the new plan, the first step is to add a new set of definitions to the previously learned priority phrases, such as PRP, P orders, etc. The most important of these new definitions are:

(1) **Controlled material:**

Carbon steel, alloy steel, copper, aluminum, and such other materials as may be prescribed from time to time, in each case only in the forms and shapes indicated in the CMP Materials List, or as otherwise ordered by the Vice-Chairman on Program Determination.

(2) **CMP materials:**

The materials on the list attached to copies of the plan. The list includes controlled materials and other materials for inclusion in bills of materials and inventory reports.

(3) **Controlled Materials Division:**

The Division of the War Production Board, which is charged with supervision over the production and distribution of any controlled material. References to decisions or actions of a Controlled Materials Division mean decisions or actions by the director of the Division.

(4) **Claimant Agency:**

War Department, Navy Department, Maritime Commission, Aircraft Scheduling Unit (Agent for Army Air Forces and the Navy Bureau of Aeronautics), Office of Lend-Lease Administration, Board of Economic Warfare, Office of Civilian Supply, and such others as may from time to time be designated by the order of the program vice-chairman.

(5) **Requirements Committee:**

The Requirements Committee of the War Production Board, under the chairmanship of the WPB Program Vice-Chairman, includes a representative of the State Department and a representative of each of the claimant agencies and passes upon the major divisions of materials for prosecution of the war. References to decisions or actions of the committee means decisions or actions by the program vice-chairman.

(6) **Prime consumer:**

Any person who receives an allotment of controlled material from a claimant agency either directly or through an office of such agency. Prime consumers whose requirements are handled by the Office of Civilian Supply receive their allotments from WPB Industry Divisions.

(7) **Secondary consumer:**

Any person who receives an allotment of controlled material from a prime consumer or another secondary consumer.

(8) **Class A product:**

Any product containing any controlled material fabricated beyond the forms and shapes specified in the CMP Materials List, except a Class B product.

(9) **Class B product:**

Any product containing any controlled material fabricated beyond the forms and shapes specified in the CMP Materials List, which is contained in the Class B List of the Controlled Materials Plan.

Washington Organization

In addition to an understanding of the terms, another requisite to proper understanding of the new procedure is a mental picture of the Washington organization that is responsible for carrying out CMP. This Washington organization centers around the seven claimant agencies, who meet together in the Requirements Committee under the chairmanship of the Program Vice-Chairman of the War Production Board. The chairman of the Requirements Committee makes all decisions after examination of the requirements placed before him by the claimant agencies. These decisions are made in terms of total tonnages of controlled materials that are allotted to the claimant agencies for: (1) production programs, (2) construction, and (3) maintenance, repair, and operating supplies. In the case of all claimant agencies other than Civilian Supply, the allotments are then suballotted through their own internal channels to the prime consumers producing finished items under agreed upon production schedules. For example, the Navy receives an allotment of steel, which it divides in a manner to obtain the maximum production from all shipyards under its jurisdiction. The Navy may vary the amounts allotted to destroyers, battleships, and the like within its own discretion except as the chairman of the Requirements Committee may make allotments earmarked for particular programs.

In the case of civilian supply, and indirect military requirements, the allotment is made to the agency, but allotments are distributed through procedures administered by the Industry Divisions of the WPB. Thus, the Industry Divisions, which have a wide understanding of the problems of each industry, will continue to be the focal point for the distribution of material to almost all producers of other than specified items purchased directly by the Army, Navy, and Maritime Commission.

Of major interest to the individual manufacturer, however, is not the overall plan of control or the Washington organization for administering that control, but just what he does to obtain delivery of the controlled—and other—materials.

Class A and Class B Products

The first question that must be answered by each manufacturer for himself is whether his product or products fall in Class A or Class B. Some manufacturers will produce both classes of products, but, for purposes of clarity, the procedure for Class A and Class B products will be examined separately.

Class B is a specifically named list of classes of products. Class A is defined as all other products containing controlled materials. In general, however, Class A products may be thought of as those products purchased directly and manufactured specifically for the claimant agencies or for their prime contractors or sub-contractors, such as tanks, ships, aircraft, tank engines, aircraft accessories, and the like. Class B products may be thought of as generators, hardware, electrical appliances, bearings, consumers' goods, and other finished items of the regular civilian economy whether purchased for civilian or military purposes. The basis on which a particular product is put in Class B by WPB is merely that it is more efficient to have the controlled materials for manufacture of the product allotted directly to the manufacturer by the Industry Division instead of having it come down through claimant agencies and other manufacturers.

If after determining the class into which his products fall, a manufacturer believes they have been improperly designated, any manufacturer of Class B products may apply to the Office of the Program Vice-Chairman of WPB for permission to be treated as a maker of Class A products. Likewise, a manufacturer of Class A products making a large variety of items that are sold to many customers and whose allotments originate from several claimant agencies, may make similar application to be treated as a maker of Class B products. Such permission will not be granted with reference to component parts or sub-assemblies, unless the necessary adjustments in Bills of Materials, which include such component parts or sub-assemblies, can be made without difficulty by the respective claimant agencies and consumers. With reference to Class A or Class B products not incorporated in other products, such permission will be granted when practical advantages are indicated.

After the manufacturer has determined the place of his products in the plan, the rest of the job divides itself into three major divisions: (1) the procedure for stating requirements; (2) method of obtaining the allotment, and (3) placing of purchase orders.

Requirements

The requirements figures will be developed by the claimant agencies through the accumulation of Bills of Materials data for each class of finished product purchased by that agency. The compiling of these Bills of Materials will fall largely upon the prime consumers under the direction of the claimant agency. Detailed instructions will be issued by the several claimant agencies concerning the make-up of these Bills of Materials. (There are two kinds—Detail Bills of Materials and Summary Bills of Materials.) In general, however, the Bills of Materials

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should indicate the gross and net weight (unless specifically exempted by the claimant agency) of each of the materials listed in the CMP Materials List, which are required for, and contained in, the complete procurement item. The exceptions to this rule will be (1) Government furnished equipment produced by other prime consumers; (2) Class B products as defined. Class B products are divided into "Group I" and "Group II." In the case of Class B, Group I, products, the Bill of Materials should list by name and part number (if available) the quantity or dollar value of each of these items required in the complete procurement items, and should show the time interval required between receipt of Class B items as such and final acceptance or delivery of the procurement item. Class B, Group II, products need not be included in the Bills of Materials of manufacturers who purchase them.

Class B: Requirements for Class B products will be compiled in two steps; (1) Each claimant agency will prepare its requirement estimates for Class B, Group I, products in number of units or in dollar value as may be agreed between the agency and the Office of Civilian Supply and submit such requirements to the Office of Civilian Supply; (2) The Office of Civilian Supply, through the appropriate Industry Divisions, will compile Bills of Materials for determining the quantities of controlled materials needed to produce required volume of finished Class B products, both Group I and Group II. The Industry Divisions of WPB will gather this information from all industries. Specific instructions have been issued to make use of figures already in existence if they will meet the needs of the plan, in order to avoid imposing a completely new statistical burden on industry.

Requirements for maintenance, repair, and operating supplies for plants owned and operated by a claimant agency will be included in the requirements of that agency and submitted to the Requirements Committee by the agency. For example, a shipyard owned and operated by the Maritime Commission would receive its maintenance, repair, and operating supply requirement through the Maritime Commission based on a statement of requirements made by that agency to the Requirements Committee. All other requirements for maintenance, repair, and operating supplies, however, will be compiled in the same manner in which the requirements for Class B products are compiled—that is, through the appropriate Industry Divisions of the WPB for presentation to the Requirements Committee through the Office of Civilian Supply. In other words, the Industry Divisions of WPB will continue the work, which is already far advanced in many industries, of making up total maintenance, repair, and operating supplies requirements for their industries.

How to Obtain Allotments

Each claimant agency will submit its statement of requirements through the Controlled Materials Divisions for preliminary adjustment and reconciliation. The Requirements Committee will then examine the adjusted figures and the chairman will make his decision regarding the division of the supply of controlled materials not later than the last day of the first month of the quarter preceding the quarter in which the allotment is to be effective, e. g., January 31 for the second quarter. These allotments of controlled materials made to the claimant agencies will not exceed the supply as estimated by the Controlled Materials Divisions for each material.

On the basis of the allotments, each claimant agency will adjust its production programs to the amount of material available. At the same time applications for allotments will be received from prime consumers using controlled materials who sell Class A products to the agency. Secondary consumers who make Class A products for sale to prime consumers or other secondary consumers will obtain their allotments from their customers. Producers of Class B products will submit their applications to the proper Industry Divisions of WPB. The application forms are a simple statement of the monthly production schedule of end products and the monthly deliveries of the controlled materials required to fill that schedule.

Upon receipt of the applications from Class A producers, each claimant agency will authorize a monthly production schedule and allot specific amounts of material for each month to fill that schedule and return the authorization to the applicant. (In order to insure capacity production of Controlled Materials, the claimant agency will be allowed to make allotments to prime consumers up to 105 percent of the allotments received from the Requirements Committee.)

In the case of Class B products, allotments of controlled materials will be made by the Industry Divisions in such a way as to insure the production of all the Class B products required by the claimant agencies unless a fabrication bottleneck prohibits the filling of all demands, in which case the requirements of the agencies for the particular Class B product will be revised by the appropriate agencies to fit fabrication capacity.

Each allotment will bear an allotment number. The allotment number is a coded number (W-1234-567-16) with a letter designating the Agency; four digits designating the Program (for total output of the item); three digits designating the schedule (for individual producer's output); and the final two digits designating the month in which the allotment applies. These months are numbered with January, 1942 as (01), April, 1943 as (16), January, 1944 as (25), and so on.

In addition to the allotment number, a preference rating is assigned with the allotment. This preference rating is used to indicate the relative urgency in connection with the purchase of fabricated parts as discussed later, and in case of conflicts of schedules.

Upon receipt of an allotment, the prime consumer will immediately sub-divide the allotment of controlled materials between himself and his immediate secondary consumers in such a way as to insure materials to meet the Authorized Production Schedule. The consumers will further sub-divide their allotments between their own secondary consumers and so on down the line until the controlled materials have been authorized to all those producing Class A products contributing to the production schedule.

Recognizing the possibility of delay in passing the allotment down the line step by step, an alternate procedure is offered in the plan for the subdivision of the allotment. Under the alternate procedure, the prime consumer will make up a complete list of all secondary consumers using controlled materials to make Class A products to be incorporated in his end products. Immediately upon receipt of his allotment, the prime consumer will notify each secondary consumer of a tentatively authorized schedule and request each secondary consumer to submit at once a proposed statement of orders for controlled materials to carry out the tentative schedule. After examination of the proposed orders and after making such modifications as may be necessary to fit the orders within the allotment, the prime consumer will notify all secondary consumers directly of the allotment and allotment number, instead of passing it down through intervening secondary consumers.

It should be noted at this point, when the plan is fully in effect (i.e., after June 30, 1943), no orders may be placed for controlled materials until an allotment number has been received, with certain minor exceptions, such as small orders from warehouses.

To facilitate the forward placing of orders, the claimant agencies are permitted to allot for quarters in advance of the quarter for which an allotment has been received. These forward commitments are limited to 80 percent of the most recent quarterly allotment for the first succeeding quarter, 60 percent for the second succeeding quarter, and 40 percent for the third and subsequent quarters. A claimant agency may allot any particular program 100 percent of its requirements for the future quarters just so the total committed by the agency is within the 80-60-40 ratio. For example, the Navy might approve allotment for 100 percent of the carrier program for three quarters in advance if this did not mean a commitment in the third advance quarter of more than 40 percent of the Navy's most recent quarterly allotment for all programs.

Placing Orders

A consumer holding an allotment number is permitted to place his purchase order with any supplier except as may be otherwise specifically directed. In such case, the consumer will be notified that his order is to be placed with the particular supplier concerned. Provision is made, however, that orders must be placed in time to comply with necessary production cycles as determined by the Controlled Materials Divisions.

To avoid piling up of orders, a mill acting under a production directive—which specifies the quantities, forms, and shapes of materials to be produced during a stated period of time—cannot accept orders totaling more than 110 percent of such production directive. Mills or suppliers not acting under production directives are limited in accepting orders to 105 percent of their expected production capacity. Each supplier is required to notify the Controlled Materials Division concerned when these limits are reached. If, despite these provisions, a consumer holding an allotment number cannot find a supplier to fill his order, he should immediately notify the Controlled Materials Division concerned and arrangements will be made to find a supplier who can fill the order.

It is provided that all orders bearing allotment numbers are to be filled during the month designated if possible, and in no case may an order be postponed later than the last day of the following month. If a mill finds itself unable to fill its orders within the designated period, it must notify the Controlled Materials Division.

In the case of steel (except castings), when an order is placed directly with a mill, a form must accompany the purchase order, showing tonnages, month of shipment, and allotment number of steel products. The steel mill will indicate its acceptance or rejection of the order on this form and will send one copy of it to the Steel Division of WPB. By this procedure, any maldistribution between the mills will be quickly caught and corrected. Also the division will have an accurate basis for issuing production directives to the mills. Similar provisions may be called for in the case of copper and aluminum.

To assist the consumer of controlled material whose orders are based on numerous contracts bearing allotment numbers authorizing the purchase of small quantities of materials, provision is made for combining any number of such small numbers, provided the customer certifies that he can support the purchase order with allotment numbers and supplies a statement showing how the allotments are divided between the claimant agencies. No such combination order shall include any item supported by a single allotment number applicable to more than the following quantities:

Carbon steel	5 tons
Alloy steel	1 ton
Stainless steel	500 lb.
Copper	200 lb.
Aluminum	100 lb.

It is expected that most small orders bearing allotment numbers will be placed with warehouses. Warehouses under CMP are given a definite status as part of the supply system and not as consumers of material. They will fill orders bearing allotment numbers within certain limits to be prescribed by the Controlled Materials Divisions. Arrangements will also be made for delivery from warehouse stocks of orders below certain tonnage that need not be accompanied by allotment numbers.

In placing orders for raw materials other than the controlled materials, the present procedure under preference ratings and other WPB Orders and Regulations will be followed.

After June 30, 1943, no preference ratings will have any effect on deliveries by producers of controlled materials. All orders for such deliveries must be accompanied by allotment numbers. Until then, orders bearing allotment numbers will take precedence over all rated orders but, to the extent that orders bearing allotment numbers do not take up the capacity of a mill, other orders may be filled according to preference ratings or applicable priorities regulations or orders.

In the case of fabricated products containing controlled materials, orders accompanied by allotment numbers will generally take precedence over all other orders, except those bearing a rating of AAA. Producers are not to accept orders bearing allotment numbers for fabricated products unless they can be filled on schedule. If fabricating bottlenecks develop, however, preference ratings will generally determine the sequence of delivery as between such orders, unless specific directions are issued to reconcile conflicting schedules. Preference ratings and priorities regulation or orders will also govern the sequence of deliveries as between orders that do not bear allotment numbers.

Detailed regulations regarding the relationship between CMP and the preference rating system will be published before allotments are made under the plan.

Construction

Procedures to be followed in connection with the allotments for construction are similar to those followed for manufactured products. Each claimant agency will submit its requirements for construction of all facilities to be used exclusively for that agency, and civilian supply will submit requirements for all construction not used exclusively for another agency. The allotments will be made through the agency in the same manner as outlined above for manufactured products with the person responsible for the construction considered as the prime consumer and all other users of material in connection with the construction projects as secondary consumers.

Inventory Control

To control inventories, provision is made that each prime and secondary consumer of controlled materials whose inventory of CMP materials is in excess of such limits as may be specified will submit an inventory following the close of each quarter. These reports will be made available to the Controlled Materials Divisions and the Material Redistribution Division of the War Production Board, and steps will be taken to reduce the inventory of each consumer where an excess is indicated.

Transition

Speed is necessary in gathering together the facts so that the plan can gear the new war schedules to the material supplies position at the very earliest date. The current schedule calls for a statement of requirements from the claimant agencies to the Controlled Materials Branches by January 1, 1943, and a decision from the Requirements Committee regarding

the second quarter allotments by February 1, 1943. This will mean that the plan will be partially operative in the second quarter of 1943. Provision is made for the transition by keeping in effect of all the present controls including PRP until the new plan is fully operative on July 1.

During the first quarter of 1943, CMP will have effect on the PRP procedure. During the second quarter, however, some producers operating under PRP will have received allotments under CMP. Such manufacturers will proceed to extend their allotments in the manner provided by CMP, deducting the total from their total authorizations under the Production Requirements Plan. Thus, if the manufacturer receives an authorization to purchase 1000 tons of steel under PRP and has received CMP allotments for 400 tons, he will extend the CMP allotment number for 400 tons and place orders for the remaining 600 tons under the preference rating provided by his PD-25A certificate. In all cases, the orders placed under an allotment number will take precedence over orders placed under the preference rating indicated by PRP.

The current P Orders will be adapted to conform to the plan in such a way as to cover the maintenance and repair requirements of those industries under the jurisdiction of the Industry Divisions of WPB.

Conclusion

CMP gives a certainty that has been lacking in the present system of first setting production schedules and then attempting to get materials to meet those schedules. CMP is only as good, however, as industry makes it by accurate statements of requirements and rapid transmission of allotments. If the plan is to succeed, it is necessary that every producer establish records and organization capable of meeting the requirements of the plan, both regarding scheduling within the plant and relations with claimant agencies and prime and secondary consumers.

Illinois Well Spacing

Permissible spacing patterns for oil wells drilled in Illinois and portions of Indiana and Kentucky have been defined by an amendment to Supplementary Order M-68-5, issued October 23 by the War Production Board upon the recommendation of the Office of Petroleum Co-ordinator for War.

The order was amended so that uniform patterns would be maintained in the areas affected by M-68-5, which allows a closer spacing of wells than usually is permitted under Conservation Order M-68.

The amended order affects the drilling of wells in

(a) The entire State of Illinois;

(b) Clay, Daviess, Dubois, Gibson, Greene, Knox, Martin, Perry, Pike, Posey, Spencer, Sullivan, Vanderburgh, Vigo, and Warrick counties in Indiana; and

(c) Breckinridge, Butler, Christian, Daviess, Grayson, Hancock, Henderson, Hopkins, Ohio, Logan, McLean, Muhlenberg, Todd, Union, and Webster counties in Kentucky.

The amended order defines the conditions under which wells may be drilled to sand formations at depths not more than 2500 ft. and at depths greater than 2500 ft.

Natural Gas Order Tightened

Faced with possible gas shortages in many parts of the country this winter, the War Porduction Board tightened control November 13, over the delivery of natural and manufactured gas by revising Limitation Order L-31 governing natural and mixed gas and Limitation Order L-174 governing manufactured gas.

Principal changes in the orders follow:

L-31 (Natural Gas)

1. Restrictions on new deliveries of gas to non-residential customers are made nationwide. Previously the restrictions were limited to certain states. November 30 was set as the deadline date for the installation of equipment that may be served in the new territories that have been added to the order. Earlier deadline dates for territories covered by previous orders remain the same. After November 30, WPB approval must be obtained for all new non-residential deliveries, except in the case of replacement of existing equipment.

2. In the case of residential customers, the prohibition against new gas deliveries apply after November 30 to all gas-heating equipment. Heretofore this prohibition did not affect small unit heaters supplying less than 50 percent of the heating requirements of the premises. In addition, the areas covered by the residential restrictions of the order has been enlarged to include portions of Arizona and New Mexico.

3. After November 30, the installation of gas equipment by both residential and non-residential consumers is prohibited if the delivery of gas for the operation of such equipment is not permitted under the order. This is intended to prevent a waste of critical materials in the installation of gas equipment which cannot be served because of a limited gas supply.

4. The schedule of curtailment to be followed by gas companies during anticipated shortages is in general continued but is made more detailed. The purpose of the curtailment schedule is to protect war producers and essential civilian services in time of shortage. Whenever necessary, the Director General for Operations is authorized to require gas companies to curtail deliveries to residential consumers.

L-174 (Manufactured Gas)

L-174, which governs the production and distribution of manufactured gas, has been amended to conform closely to the new provisions of the natural gas order. The principal change is to prohibit the installation of gas equipment in cases where delivery of gas to such equipment is prohibited under the order. In addition, the amendment provides for the submission to WPB of curtailment schedules in advance of anticipated shortages.

Production Research and Development

Establishment in the War Production Board of an Office of Production Research and Development, and appointment of Dr. Harvey N. Davis, president of the Stevens Institute of Technology, as its director, were announced November 9 by Chairman Donald M. Nelson.

The office is being set up in order to insure rapid appraisal and the quickest and most effective utilization of processes, materials, mechanisms and inventions in the production of war goods.

Nelson pointed out that the office will parallel in the production field the work already being done in regard to instruments of war by the Office of Scientific Research and Development, and that it was set up after consultation with Dr. Vannevar Bush, head of the Office of Scientific Research and Development.

In general terms, the Office of Production Research and Development will have four principal functions:

1. To provide the chairman with technical information on problems with which he is directly concerned and on research and development work in progress in WPB. The office is also to provide the WPB divisions and branches with research information and findings on work which they have in progress.

2. To initiate evaluation and analysis of specific scientific or technological proposals, through the establishment of expert committees or through reference to existing research groups in government, education, and industry.

3. To get needed research accomplished, by contracting with outside laboratories or agencies for experimental work.

4. To bring about development of such projects or processes as are found to merit it, through contracting for the construction of prototypes or the erection of pilot plants.

As director of the Office of Production Research and Development, Dr. Davis will serve as technical adviser to the chairman on engineering and scientific matters. It is his general responsibility to initiate such technical evaluation, research and development work as will in his judgment advance the war program.

Nelson emphasized that the work of the new office will not overlap or duplicate work being done by WPB's industry branches or divisions. Before undertaking any research or development program directly concerning a material or product which is under the jurisdiction of a branch or division, Director Davis will consult with the Director General for Operations and with the head of the branch or division involved. Branches and divisions will keep the office advised of progress and results of such research or developmental work as they have in progress.

All proposals or suggestions received by the director regarding natural or synthetic rubber will be referred to the rubber director for action.

Establishment of the Office of Production Research and Development follows extensive study by WPB of ways and means through which war production might be advanced through more extensive use of new processes, materials, inventions or techniques. Early last summer a special committee reported to Nelson that a special office should be established within WPB to handle such matters; more recently, another committee, headed by Dr. Webster N. Jones, director of engineering, Carnegie Institute of Technology, made specific recommendations about the manner in which such an office might be set up and the fields in which it could most effectively operate.

In its report, Dr. Jones' committee predicted that: "real benefit will be derived" from the establishment of such an office, and added:

"Such an office would co-ordinate technical effort; it would insure more rapid and effective evaluation of new ideas, mechanisms, processes and inventions; it would utilize, so far as possible, existing research personnel and facilities; it would provide co-operation in technical matters with other governmental organizations."

Except for contracts connected with the rubber program, all contracts by WPB for research and development work by other governmental agencies, colleges and universities, commercial laboratories and corporations, and others, will be handled by Director Davis.

His appointment as director of the newly-established office marks Dr. Davis' second experience in government war service. In 1918 he served the Army Air Service as aeronautical mechanical engineer, continuing as an adviser in that field until 1922.

Order L-221 Applying to Motors

A purchaser of an electric motor must show that the horsepower of the motor he is applying for is no greater than that required to do the job, according to a provision in General Conservation Order L-221, announced December 4 by the Director General for Operations.

Officials of the General Industrial Equipment Division pointed out that it has been the practice of industry for many years to "over-motor," that is, to apply greater motor capacity than necessary for the job to be done. As a means of stopping this practice, the order applies certain measurements by which the actual power requirements may be related to the horsepower of the motor applied for by the purchaser.

L-221 prohibits the delivery or acceptance of motors, unless they comply with certain standard specifications and are of the simplest practicable, mechanical and electrical design. It also requires the purchaser to certify and show reason why he must have a motor of a special type; and it restricts the use of such special types to the conditions and the purposes for which they are required. For example, it limits the use of explosive-proof motors to hazardous locations.

One of the important conservation provisions in the order applies to both motors and generators. It requires the applicant to certify that he has made every reasonable effort (1) to adapt idle motors or generators in his possession, (2) to obtain used ones for his purpose, and (3) to repair or recondition his existing equipment.

Where used equipment cannot be obtained within a reasonable time by the applicant, it is suggested that he make his needs known to WPB's Surplus Used Equipment Branch, which will assist him in meeting them.

It is estimated that the conservation and simplification provisions in the order will save in one year about 15,000,000 lb. of copper, 55,000 tons of carbon steel, and 150,000 lb. of stainless steel.

The order became effective December 10, 1942.

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P 967.6

Synthetic Rubber From Petroleum[1]

☆ With research rapidly accelerating, the synthetic product in time may replace natural rubber

by Gustav Egloff

Director of Research, Universal Oil Products Company

AS ONE engaged in scientific and technical research, I have followed with great interest the progress of Farm Chemurgic to bring about greater application of science to our daily lives, and to the problems in agriculture in particular. My keenest sympathy has been with your efforts to awaken America to the need of utilizing science and technology to improve conditions in agriculture.

That these views have not been held in our country until a short time ago is so much water over the dam, but today I say that the people of the United States not only should not—they must not and need not—ever again be caught in the serious predicament from which we are all suffering: namely, a shortage of rubber that is so vital in our daily lives and to the United Nations at war.

Our economic life has been disrupted due to the fact that more than 95 percent of the world's natural rubber supplies are in the hands of the Japanese.

Ever since the automobile became a major part of our national economy, two factors have been uncontrollable: first, the growing of rubber trees situated 10,000 miles away, and second, the actual production of rubber. Automobile and fuel technologists have made an exact science of the operation of the automobile mechanism, but the tires upon which it runs, until the present time, have been dependent upon a temperamental rubber tree and the idiosyncracies of a little brown boy who gathers the rubber latex.

Rubber Needs Doubled

We have been catapulted into a synthetic rubber program with a speed that is hair-raising. The Baruch Committee in September, 1942, recommended that we produce at the rate of 1,106,000 tons of synthetic rubber a year. Our peacetime consumption of natural rubber was about 600,000 tons yearly.

Fortunately, the United States has the raw materials and processes to produce synthetic rubber not alone from petroleum and coal but also from agricultural products. Literally an army of research workers and technologists are to produce synthetic rubber and continually improve upon its properties at expenditures of millions of dollars yearly.

Out of the researches going on in the United States, new synthetic rubbers will be developed with far superior properties to anything nature or man has ever produced. Even today some synthetic rubbers have special properties and uses for which natural rubber is worthless. Synthetic tires are being developed that give wear properties and safety to human lives not inherent in natural rubber. The life of these tires will be at least several times that of natural rubber. History will again repeat itself as in the case of silk. Nature's product, natural silk, spun by worms, has been superseded in quality and wear by a substitute silk—Nylon. And, the mileage on milady's Nylon hose is now more than ten times the best product that the silkworm ever produced. The cost of Nylon hose in relation to the natural silk is of the order of one-tenth, at least on a mileage basis. We may look confidently into the future — that rubber tires will go through the same evolution as natural silk to Nylon. Good as the mileage of natural rubber tires is, the synthetic may ultimately reach ten or more times that of nature's product from the rubber tree.

The purpose of this Chemurgic Conference at Cincinnati is, I take it, to contribute if possible to progress in finding industrial uses for products of the farm. I am glad to be here as a representative of the petroleum industry. Without pretending to know much about agriculture, I am convinced nevertheless that the petroleum industry has many points of contact with agriculture, and that the two industries have important interests in common.

GUSTAV EGLOFF

was born in New York, New York—Graduated with A.B. degree from Cornell University, 1912—Received A.M. degree from Columbia University in 1913 and Ph.D. degree from the same institution in 1916—Served with U. S. Bureau of Mines and Aetna Chemical Company in 1915 and 1916—Since 1917 he has been affiliated with the Universal Oil Products Company, Chicago, Illinois, as director of research—Is president of the American Institute of Chemists.

Petroleum Industry and Agriculture

In its relations with agriculture the petroleum industry has been both customer and supplier. As a customer or a purchaser it has for many years provided the market for a subsurface crop from the farms of this country. It has been estimated that oil company payments to farmers for oil taken from their lands total about $280,000,000,000 a year.

The petroleum industry has been a purchaser of the products of the land for use as constituents of its products or for supplies in the operation of its processes. In drilling wells, for example, sugar cane bagasse, wheat bran, and cottonseed hulls are among the materials used to plug porous underground formations.

There is not a farm of consequence in the United States that is not visited at frequent intervals by the supply vehicles of the petroleum industry. No other supplying industry is more seriously interested in the farmer's problems and his welfare. No other, if we want to put the discussion on a purely utilitarian basis, stands to benefit more directly from making its services to the farmer worthwhile. The farm industry

[1]Address before National Farm Chemurgic Council, Third Mid-American Chemurgic Conference of Agriculture, Industry and Science, Cincinnati, Ohio, November 17, 1942.

and the petroleum industry are never going to get very far apart no matter what issues may arise before congressional committees and in the press between their separate but coöperating industries. They are not even likely to have any lasting difference over the question of synthetic rubber.

Gasoline Rationing

The oil industry will lose a major part of its market for gasoline and motor oil through the restrictions that the rubber shortage has caused to be placed upon operations of motor vehicles through gasoline rationing. It is of much greater importance to the oil industry to get that market back than it could possibly be to gain for itself a market for that relatively small quantity of petroleum needed in the manufacture of synthetic rubber. The rationing of gasoline as proposed will cut down the consumption of gasoline for motor vehicles more than 30 percent of the total consumed last year: 28,000,000,000 gal., which means a loss of income to the oil industry of more than one billion dollars a year, due to the fact that we shall not have sufficient tires to operate the motor vehicles. The oil industry has a vital interest in seeing that cars are provided with tires, and would therefore do everything possible to see synthetic rubber made from alcohol, or coal, or guayule, or any other raw material from which it could be made more quickly than from petroleum.

When the need for synthetic rubber became so critical after the disaster at Pearl Harbor, the petroleum, rubber, and chemical industries were ready to tell the government how to make it. A number of petroleum companies even had small scale commercial and pilot plants in operation producing the necessary raw materials. It was therefore nothing less than a duty for the petroleum industry to place its knowledge at the disposal of the government and to proceed with the erection and operation of commercial scale plants as ordered by the government.

For all practical purposes the controversy regarding whether it is best to make synthetic rubber from petroleum or alcohol or other material has been settled by the Baruch Rubber Committee, which has decided that the plants already agreed upon should proceed according to schedule. They have also given most of the known processes an opportunity to be tried out in ways that will delay as little as possible the actual production of critically needed rubber. Whether that decision was right, or whether the emphasis should have been placed more on alcohol, time and the inexorable facts that will be deduced from actual manufacturing experience will tell. In the meantime, synthetic rubber will be produced. The petroleum industry will naturally yield to whatever lesson experience teaches. Meanwhile, it will continue to do what is conceived to be its bounden duty by applying the "know how" it has already gained in the building of plants and the production of materials for synthetic rubber as swiftly and efficiently as possible.

Kinds of Synthetic Rubber

Natural rubber is made up almost exclusively of carbon and hydrogen in chemical combination, and so far as we know is a multiple of the hydrocarbon called *iso*prene. Natural rubber may be derived from many types of plants, such as guayule, cryptostegia, the sunflower, koksagyz, goldenrod, milkweed, and a host of others, giving a varying percentage of a latex that can be worked up into rubber. Natural rubber has been known for thousands of years and has been found in the tombs of the ancients. So far as is known, the first rubber trees of moment were those found in Brazil, the botanical name for which is Hevea brasiliensis. The seeds of the Brazilian rubber trees were transplanted in the Far East by the British and the Dutch, and huge plantations resulted. The rubber tree is slashed in a herringbone effect and a white material called latex oozes out and is collected, the rubber from which may be gathered by precipitation with mineral acids or burned over a slow fire, which is the native method of recovering rubber in Brazil. No successful methods have been derived through chemistry to exactly synthesize natural rubber, which has been the goal for many years. Out of this mass of researches, however, new types of rubber have been developed, which are called synthetic. These synthetic rubbers have properties many of which are superior to the natural. In this world struggle, to which rubber is so essential for bringing about a successful conclusion, four types of synthetic rubber are in commercial production. The most important of these synthetic rubbers is the Buna-S type, which results from the chemical combination of butadiene and styrene. Commercial units are being installed to produce the Buna-S type at the rate of 705,000 tons a year, with another 140,000 recommended.

Another type of rubber called Butyl will be produced at the rate of 132,000 tons a year. Butyl rubber is a result of the reaction of *iso*butylene (98 percent) and *iso*prene (2 percent).

The Neoprene type of synthetic rubber is based upon acetylene. Commercial plants for 49,000 tons a year capacity are being installed, with another 20,000 recommended.

The production of Thiokol type rubber has been recommended at the rate of 60,000 tons a year.

At present production of butadiene is scheduled at the rate of 705,000 tons. It will be produced from raw materials as shown in the following table:

Raw materials	*Butadiene, tons*
Grain alcohol	242,000
Butylene	283,000
Butane	66,500
Refinery (conversion processes)	20,000
Refinery conversion processes and butene combinations	93,500
	705,000

The Baruch Committee has recommended another 100,000 tons of butadiene to be derived from refinery processes in order to provide the quantity necessary for the increased 140,000 tons of Buna-S rubber. Hence there is a total of 805,000 tons a year of butadiene that will be required for the projected program for synthetic rubber.

Butadiene is the key hydrocarbon in the production of synthetic rubbers. There are more than 80 different types of material that, under some experimental conditions in the laboratory, will produce low and high yields of butadiene. Butadiene was first reported upon by Bouchardat more than 100 years ago when he distilled a natural rubber and obtained butadiene as one of the reaction products.

The conversion of ethyl alcohol into butadiene has been known for more than 40 years. The reaction was discovered by Dr. V. N. Ipatieff of Universal Oil Products Company. The Russians were the first to use the process commercially, beginning in the year 1930, and are reported to be producing butadiene type of synthetic rubber at the rate of 100,000 tons a year.

Butadiene from Grain Alcohol

One of the commercial processes in the U. S. A. for producing butadiene is from grain alcohol. The present synthetic rubber program will call for about 90,000,000 bushels of grain per year to produce the 242,000 tons of butadiene, about 35 percent of the butadiene requirement in the rubber program.

One of the primary methods of producing butadiene will be by the catalytic dehydrogenation of butylene. Butylene is a by-product of the thermal and catalytic cracking of oil to produce aviation gasoline. The butylene can also be converted into aviation gasoline by a reaction with *iso*butane. Only

Oil Tool Manufacturers' Secret Weapon...

the "Know How" in a machine age war

DOING the impossible is the every-day experience of oil tool manufacturers. It, therefore, did not astound executives of these companies to be asked to rearrange their plants, tool up, manufacture, and deliver implements of war on "impossible" schedules. That so many of them are doing this along with other manufacturers throughout the nation is proof that the Axis war lords miscalculated the power of the United Nations' secret weapon . . . the "know how" in a machine age.

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Here at Mission it is our privilege to bring both speed and precision to war work . . . speed learned in meeting the requirements of the fastest moving of all industries, oil . . . precision learned in manufacturing Mission products to extremely close tolerances.

When peace comes and the oil industry is forced to greatly expand to take its share of America's bigger place in the world of industry, oil men will find at Mission the same progressiveness in the design of oil industry products that has made it a leader. In the meantime, we want you to call on us for ways of making the Mission tools you now have give better performance and longer service.

●

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part of the butylene produced in refinery operation will be used for butadiene production. The dehydrogenation of butylene will be at a yearly rate of 283,000 tons.

Butane derived from refinery or natural gas is also a source material for butadiene via catalytic dehydrogenation at high temperatures. The scheduled rate will be 66,500 tons a year.

The oil industry is using existing equipment converted to the high temperature cracking of petroleum fractions to produce butadiene at temperatures of 1400°F. This reaction may take place in the presence of superheated steam, flue gas, or partial oxidation with air to raise the temperature to the cracking point. In addition to butadiene by cracking of gasoline, ethylene, propylene, butylenes, benzol, and toluol are produced, which are useful in aviation gasoline, high explosives, and synthetic rubber manufacture.

Butadiene from Coal and Limestone

To produce butadiene, the Germans use coal and limestone, which are converted in electric furnaces to calcium carbide at great electrical energy costs. The calcium carbide is converted into acetylene by the action of water thereupon. The acetylene is then converted into butadiene through four chemical steps, i.e., acetaldehyde, aldol-condensation product, butylene glycol, and then dehydration to butadiene. Ethyl alcohol seems to pass through a similar set of reactions when dehydrated-dehydrogenated into butadiene.

The U. S. Department of Agriculture is experimenting with another source of butadiene derivable from fermentation of grain to the product 2, 3-butylene glycol. This product is then dehydrated to butadiene. It is one of the methods for producing butadiene that is receiving serious consideration.

Another group is working to produce butadiene from butyl alcohol derived from the fermentation of grain. The butyl alcohol is dehydrated into butylene, exactly the same compound as produced from cracking of oils, and then is dehydrogenated into butadiene. It is of interest to point out at this stage that ethyl alcohol is produced from the fermentation of grain through enzyme fermentation of a particular type, whereas butylene glycol requires another type of bacteria, and butyl alcohol still another type. All three compounds producible from grain are convertible into butadiene at a price. The price of products of course plays no marked role in a war economy. The important point is speed of production with minimum outlay of strategic materials in the form of copper, chromium, etc.

Another important component of synthetic rubber for Buna-S is styrene. Styrene is a hydrocarbon that is a resultant of a reaction between benzol derived from coal and ethylene to form ethylbenzene, which is dehydrogenated to styrene. The ethylene used in this reaction may be produced from grain alcohol by dehydration or cracking of hydrocarbons. Commercial plants to produce ethylene from grain alcohol have been proposed for the production of ethylene. The oil industry has proposed an ethylbenzene process for the rubber program from the direct reaction of grain alcohol and benzene using a solid phosphoric acid catalyst. The latter when spent may be used as a fertilizer.

When butadiene (75 percent) and styrene (25 percent) are mixed together in the presence of a catalyst, a solid product, Buna-S type of rubber, results.

Butyl Rubber

Butyl rubber, a development of the oil industry, is a highly important contribution to the war effort. *Iso*butylene (98 percent) is the key hydrocarbon that reacts with *iso*prene (2 percent) to produce Butyl rubber. The *iso*butylene and *iso*prene are produced from petroleum. The *iso*prene is exactly the same hydrocarbon that is derived from natural rubber when distilling it at elevated temperatures. The rubber decomposes into primarily the hydrocarbon *iso*prene. The *iso*butylene is derived from thermal or catalytic cracking of petroleum. Butyl rubber will be used for necessary civilian war production, transportation, etc.

Another type of synthetic rubber called Thiokol is produced by chlorination of ethylene, which is then thoroughly agitated with sodium poly sulphide. The ethylene for this reaction may also be produced from the cracking of petroleum or by the dehydration of grain alcohol. Hydrogen sulphide is present in varying percentages of natural or refinery gases and may be read-

TABLE I

Natural rubber tire

Tread	*Parts*	
Smoked sheet	100	
Carbon black	50	Cure in 60 min. at 30-lb. steam or
Zinc oxide	5	45 min. at 40-lb.
Sulphur	3	
Stearic acid	3	
Pine tar	4	
Accelerator (captox)	1	
Antioxidant	1	

Carcass		
Smoked sheet	100	
Zinc oxide	5	
Sulphur	3	60 min. at 30-lb.
Stearic acid	1	
Pine tar	4	
Accelerator	0.8	
Antioxidant	1-1.5	

Truck tire carcass

Same as above except that 50 parts of zinc oxide are used instead of 5

Cotton yarns

Fabric is roughly 30-35 percent of the total weight

Synthetic rubber tire (Buna-S type)

Tread	*Parts*	
Buna-S	100	
Carbon black	50	(softer type of black)
Zinc oxide	5	
Stearic acid	2	
Softener	5	—rosin or coal tar oils BRT No. 7
Captox	1.5	—or Santocure
Sulphur	2	

Carcass	*Parts*	
Buna-S	100	
Soft black carbon	40	—may be 30 to 40, such as P-33 or
Zinc oxide	5	blend of channel black 20 and
Softener	15	P-33, 20. Or may use 20 parts
Captox	1.5	in all—10 soft black and 10 with
Sulphur	2	channel black

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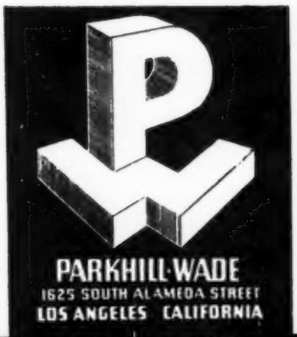

- ***Distillate Recovery Plants***
- ***Gas Dehydration Plants***
- ***Compressor Stations***
- ***Natural Gasoline Plants***
- ***Stabilization Plants***

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ily converted into sulphur. This sulphur is then reacted with caustic soda to produce sodium poly sulphide. After reacting ethylene with chlorine, the dichloroethane formed reacts with the poly sulphide yielding Thiokol. The primary use of Thiokol will be in the retreading or recapping of tires.

A hydrocarbon of the greatest import is acetylene, which is used in the production of the synthetic rubber called Neoprene. Acetylene is also the base material for Nylon, a substitute for natural silk. Acetylene is produced from coal and lime via the calcium carbide production in electric furnaces requiring a great deal of electrical power, of which the nation is short. Acetylene when treated with hydrochloric acid and a catalyst forms Neoprene. It is therefore of importance to advise that acetylene is to be produced commercially from petroleum or natural gas under very high temperatures. Two commercial acetylene units are being installed, one of which will produce acetylene at the rate of 27,000 tons a year. Other units are also projected. It is believed that acetylene can be produced at a lower cost from processing hydrocarbons than by the electrical method of producing calcium carbide.

A synthetic rubber named Buna-N, or perbunan, is being produced commercially by private capital. This type of rubber has many specialized important uses. It is produced from the reaction of butadiene and acrylonitrile in the presence of a catalyst. The acrylonitrile component is also readily made from natural gas or petroleum.

In fabricating a rubber tire, whether synthetic or natural, one of the important components is carbon black or furnace black, which is producible from natural gas, and from petroleum. These carbonaceous materials are important components whether blended with natural or synthetic rubber, particularly from the standpoint of improving the tensile strength and wearing qualities of the tire under service conditions. In the year 1940 about 369,000,000,000 cu. ft. of natural gas were converted into carbon black by the air-oxidation method using the so-called channel process. This volume of natural gas yielded about 285,000 tons of carbon black, of which 85 percent was used in tires. So far as tests are concerned, furnace black appears to be a superior type of carbon for use in synthetic tires.

Natural vs. Synthetic Tire

The approximate composition of natural and synthetic tires, which vary as a function of the type of use intended, i.e., treads and carcasses, is shown in Table 1, given for natural and synthetic rubber.

It is of importance to note that about one-third of the total weight of the tire—30-35 percent—is made of cotton. When the total weight of tires fabricated in the United States is considered, the amount of cotton required for their manufacture is considerable. Rayon yarns have also been used in tire fabrication with good results.

The world's natural rubber production for 1941 was about 1,675,000 long tons, of which the United States imported something over 800,000 tons. Ninety-five percent of the world's natural rubber sources have been lost to the United Nations. Russia lost two of her synthetic rubber plants in the Ukraine. Airplanes, tanks, trucks, ships, trains, gun mountings, etc., require rubber in ever-increasing amounts, and this does not include the necessary increase for civilian users in the war effort. Some of the tires used by the Army weigh more than 3500 lb. A medium size tank requires 500 lb., small pontoon bridges 1000 lb., and the gasoline tank of a flying fortress requires 500 lb. of a bullet-sealing type of rubber. A battleship calls for from 75,000 to 150,000 lb. of rubber, and a gas mask ¾ lb. There are many hundreds of products that require rubber in the war effort. These are barrage balloons, blimps, rafts, life vests and suits for flyers, rubber boats, and hospital rubber needs. Rubber is required also in one form or another by the many millions of men on the fighting fronts.

U. S. Arsenal for Allies' Rubber

Preparations to make synthetic rubber in the United States at a rate of 886,000 tons a year involving plant costs of about $800,000,000, are already under way. The Baruch Committee has recommended that this tonnage be increased to 1,106,000 tons a year. In addition to being the arsenal for many other war products, synthetic rubber will also have to come from the United States to supply our allies' needs. It may well be assumed that even 1,106,000 tons of synthetic rubber will

Wage-Hour Division Rules on Transportation Problem

Recently the American Association of Oilwell Drilling Contractors asked Edward J. Florer, Regional Director, Wage-Hour Division, at Dallas, Texas, whether it would be permissible to delegate one man in a drilling crew to take care of transportation of the entire crew to and from work, this man to receive a small compensation, for use of car only, from the drilling contractor (employer) for such transportation. It was explained in the request that drilling contractors did not want to become involved in transportation that might call for travel time for employees, as it long has been the custom for crews to transport themselves to and from the job in any way they saw fit. The following reply was received from the Regional Director:

"This will acknowledge receipt of your letter of November 27, 1942. You state therein that you are having difficulty in obtaining workmen for oilwell drilling crews because the work is located in remote areas and due to the present transportation difficulties.

"It appears that it has always been a custom in the industry for members of such drilling crews to furnish their own transportation, traveling in such manner as they desire and at their own convenience. It appears now, however, that you wish to have one member of the crew transport the others in his automobile for which he is to receive a small sum of compensation which is to be for wear and tear on the automobile only. You ask if this is permissible.

"You may, of course, post one member of a crew to furnish transportation for the other members to and from their work, either in his automobile or one furnished by the company. Such an employee, however, must have the time taken in such transportation counted as hours worked and he must be compensated therefor in accordance with the Act. As to the employees transported by him, such time need not necessarily be counted as hours worked, as it may be assumed that the other employees are free to travel by other reasonable, available means of transportation, that it has been the custom for such employees to transport themselves to and from work, and they may still do so, and if the employees were not required to report at a certain place prior to proceeding to work, then such time for such other employees need not be considered hours worked, provided that the further assumption may be made that there will be nothing else which would require the time spent in travel to be considered hours worked."

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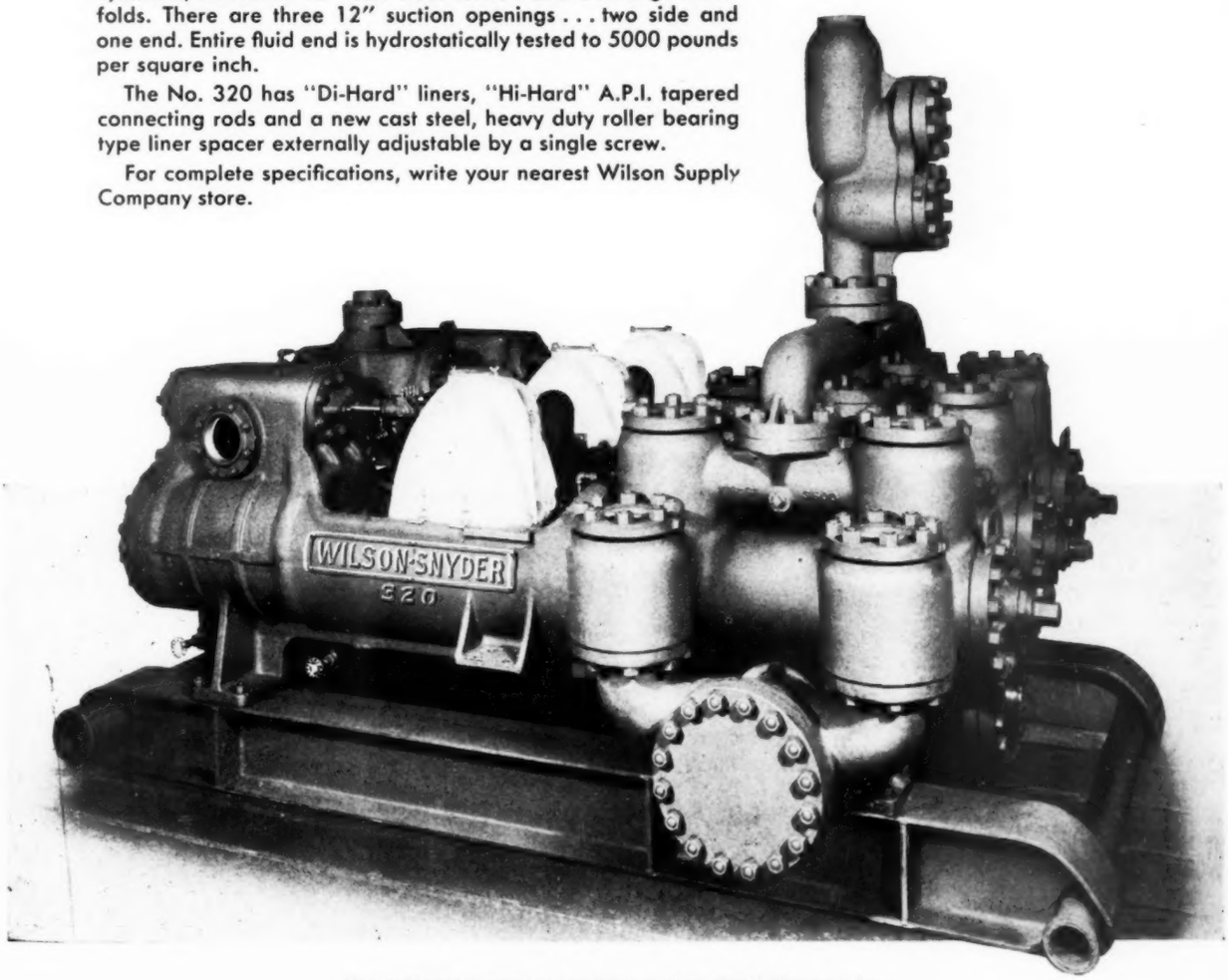

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be too little for the United Nations' requirements.

As has been said, the synthetic product does not attempt to duplicate the natural in any way. In general, it can be said, however, that some synthetic rubbers are at least equivalent to the natural product, and it is certain that many properties have been enhanced through research on synthetic rubber, as the product is superior in gasoline, oil, and chemical resistance. It is also more stable to light and air and has greater wearing properties. Tests with synthetic rubber tires have shown that the synthetic tired vehicle goes uphill with very little side-slipping, and when operating the car on curves at high speeds the synthetic tire is safer than the natural. With the large number of research men in the field of synthetic rubber and with expenditures of millions of dollars yearly, it can well be predicted that synthetic rubber tires will evolve with a life at least equal to that of the motor car. In many instances, the synthetic rubber industry might well be likened to the production of other synthetic products that occurred during the first World War, the most notable of these being the production of synthetic nitrates from the air. For many years the Chilean nitrate deposits were the only ones worthy of note throughout the world, and the owners operated a virtual monopoly of these resources. As in the case of rubber, it was necessary to begin with the materials indigenous to the U. S. A. Since the conclusion of the first World War the Chilean nitrate deposits have not been worked on the same scale as before. It might well be that the natural rubber plantations will enter the same sort of period as the nitrate deposits.

100,000 Miles Per Tire

One may well ask the question, why the Rubber Reserve Corporation production capacity schedule has emphasized the Buna-S and Butyl types of synthetic rubber. This is readily understandable due to the fact that the oil industry knew how to produce these products and had the raw materials available, as well as the "know how." So the oil industry went ahead and accepted the responsibility of producing the raw materials for these two type rubbers. The Butyl type is solely a development of the Standard Oil Company of New Jersey, and is a 100 percent American process. The oil industry also had the "know how" of producing the raw materials for the Buna-S type. The agricultural division of our economic life has also fitted into the picture of producing butadiene and ethylene. The costs involved in producing synthetic rubber of the Buna-S type will ultimately work on a mass production basis and be less than 15 cents per lb. When one takes into account the increased wear (100,000 miles per tire) and safety properties that will be present in synthetic tires based on continued research, cheaper raw materials and processing costs on a relative basis, the synthetic rubber will be sustantially cheaper than the natural. As of today, so far as the World War is concerned, the cost of synthetic rubber is relatively unimportant. What is really important, however, is the saving of critical materials and the high speed of getting on the production line—that is what counts, and should be the primary determining factor in having rubber for every war need quickly. It is not now a question of being concerned about the post-war period, for that period will in our competitive system come to the processes that are most economic. Grain alcohol or any other products from agriculture should be used to the maximum of their capacity at present wherever to do so will speed up the war effort toward a successful conclusion for the United Nations.

Out of this World War will flow some good—certainly as it relates to synthetic rubber from the standpoint of greater safety in motor vehicle, travel, etc. One may be certain that, good as synthetic rubber is today, it will be far surpassed by that yet to come with the thousands of research men experimenting continually on this problem. Natural rubber will go the way of the silkworm, of natural nitrates, indigo, quinine, and other natural products that man has superseded by synthetics. It must be understood that synthetic products means, not inferiority, but on the contrary, in general may be vastly superior to the natural. There can be no doubt that with intensification of research men in agriculture new uses, new products, will flow from the scientists working in their laboratories and technologists working to convert the laboratory research into something useful to mankind.

After the war the manufacture of synthetic rubber will be a major industry capable of supplying the entire country with products meeting its every need. Whether the raw materials come from petroleum, coal, or alcohol still remains to be worked out during an economy not based on war. Should alcohol become the major source the petroleum industry will coöperate in every way possible as has been done in the past. Should the petroleum industry continue in its present role of the chief raw material supplier for synthetic rubber, it will serve in that respect as it has served in supplying other petroleum products to be a chief assistant in making agriculture easier, more fruitful, and more profitable.

It is the deep wish of the oil industry to see the agricultural industry prosperous and to see many new uses develop from its products. The government has many laboratories engaged in problems of agriculture. May they work out processes of great usefulness to all of us.

☆ ☆ ☆

Canadian Requirements on Same Basis as U. S.

Canadian requirements for petroleum and petroleum materials henceforth will be considered on the same basis as those of the United States, Petroleum Administrator for War Harold L. Ickes has announced.

Details of the plan to handle Canadian requests for materials on a par with similar requests from United States operators were included in a letter addressed to Dominion Oil Controller G. R. Cottrelle by Deputy Administrator Ralph K. Davies.

The Deputy Administrator wrote:

"On the basis of (conferences) and in the spirit of the Hyde Park agreement and the Canada Proclamation, I now wish to advise you that as respects all forms of consideration given all Canadian petroleum matters by this Office, Canada will henceforth rank on precise parity with the United States.

"As soon as the indicated arrangements can be made fully effective, the revised procedure for Canadian petroleum will assure the following important objectives:

"1. A closer community of interest between Canada and the United States on all subjects relating to petroleum.

"2. The inclusion of Canadian requirements for petroleum and petroleum materials with those of the United States for applications to, and allocations by, the War Production Board.

"3. The consideration of Canadian petroleum war plants as integral units of the United States war plant construction program and the scheduling of material deliveries in harmony with that program."

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 66

THE Continuous Tables were adopted as a valuable and regular feature of *The Petroleum Engineer* six years ago. Throughout the last five years the original objective of the tables, to save time and effort for the technician and the practical field or plant worker, has been strictly adhered to. As a result, their reception has been such as to lead the editors to believe that they are accomplishing their original objective. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.*

A part of the original objective of the tables was the presentation of the data in the simplest form available—tabular form data are believed the most accurate and readily followed by the average reader than any other method available. There are many types of information best presented by curves or nomographs when three or more variables must be considered simultaneously. Such data as must be presented in the form of charts and graphs were begun with the 62nd installment.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions.

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24-HOUR CAPACITY* OF 4-IN. BY 1½-IN. ORIFICE PLATE—FLANGE CONNECTIONS

Pressure, lb. per sq. in. ga.	Differential, in. of water										
	5	10	20	30	40	50	60	70	80	90	100
10	159	224	317	389	448	501	550	593	635	673	709
20	208	267	376	461	533	596	652	705	754	798	843
30	214	303	428	524	604	676	741	801	856	907	956
40	237	334	474	580	670	749	820	886	948	1005	1060
50	257	365	515	632	729	815	893	963	1031	1095	1153
60	277	392	554	678	784	876	959	1037	1108	1174	1239
70	294	419	590	722	834	933	1022	1104	1180	1252	1319
80	312	441	624	764	883	986	1081	1167	1248	1324	1395
90	329	464	656	804	927	1038	1137	1228	1312	1391	1467
100	343	485	686	841	972	1085	1190	1285	1374	1457	1536
110	357	507	716	877	1012	1133	1240	1339	1433	1519	1601
120	372	527	745	912	1052	1177	1289	1393	1489	1579	1664
130	386	546	770	945	1091	1220	1337	1443	1543	1637	1726
140	401	564	798	978	1128	1262	1383	1493	1595	1693	1785
150	412	583	823	1008	1164	1302	1426	1540	1647	1746	1841
160	424	600	848	1038	1199	1341	1469	1586	1696	1799	1897
170	435	616	871	1068	1233	1378	1510	1631	1744	1849	1950
180	448	633	896	1097	1266	1416	1551	1675	1790	1899	2001
190	459	649	917	1124	1298	1451	1589	1717	1836	1947	2053
200	469	665	940	1151	1329	1486	1628	1759	1881	1994	2102
210	481	681	962	1179	1360	1520	1665	1799	1924	2040	2151
220	491	695	983	1205	1390	1555	1703	1839	1965	2085	2198
230	502	709	1004	1229	1420	1586	1739	1878	2007	2129	2244
240	513	724	1024	1255	1448	1619	1773	1915	2049	2172	2290
250	524	738	1044	1279	1476	1651	1809	1953	2087	2215	2334
260	533	752	1064	1302	1505	1681	1842	1990	2128	2255	2379
270	541	765	1083	1327	1532	1711	1875	2026	2165	2297	2421
280	551	779	1101	1350	1558	1741	1908	2062	2204	2337	2464
290	560	792	1120	1373	1584	1772	1940	2096	2241	2376	2505
300	570	805	1138	1394	1609	1800	1971	2131	2277	2415	2545
310	579	818	1157	1417	1635	1829	2003	2164	2313	2455	2586
320	587	830	1174	1439	1661	1856	2033	2197	2340	2491	2626
330	596	843	1192	1459	1685	1884	2063	2230	2383	2528	2665
340	604	854	1209	1480	1710	1911	2093	2261	2418	2564	2703
350	612	867	1226	1502	1733	1938	2123	2293	2451	2600	2741
360	622	879	1242	1522	1757	1964	2152	2324	2485	2636	2778
370	632	890	1259	1542	1780	1990	2181	2355	2518	2670	2815
380	637	902	1275	1562	1803	2016	2208	2386	2550	2705	2851
390	646	913	1291	1581	1826	2042	2237	2415	2583	2739	2887
400	653	924	1306	1601	1848	2066	2264	2445	2614	2772	2923
410	662	936	1322	1619	1870	2092	2291	2475	2646	2805	2958
420	669	946	1338	1640	1892	2116	2317	2504	2676	2838	2992
430	676	958	1354	1658	1914	2141	2344	2533	2708	2871	3026
440	685	968	1368	1677	1935	2164	2370	2560	2738	2903	3061
450	692	979	1384	1694	1957	2188	2396	2589	2767	2935	3094
460	699	989	1398	1713	1978	2211	2422	2616	2797	2966	3127
470	706	999	1413	1730	1998	2234	2448	2643	2827	2998	3160
480	714	1009	1427	1749	2019	2257	2472	2670	2851	3028	3193
490	721	1019	1441	1766	2039	2280	2498	2698	2884	3059	3225
500	728	1029	1456	1783	2059	2303	2522	2725	2913	3090	3256

4-in. x 1½-in. orifice plate size, flange connection.

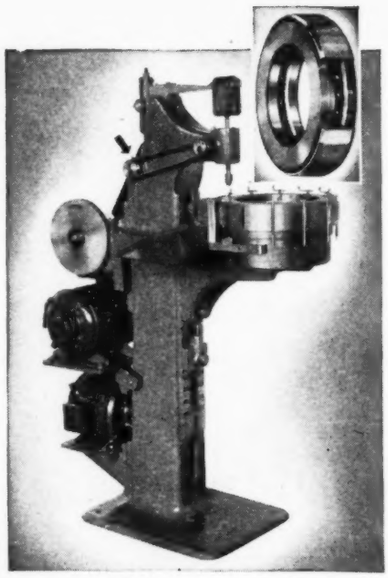
*Million cu. ft. based on (4 oz.) 14.4 lbs. per sq. in., 0.60 gravity, and 60°F. temperature.

1 hour coefficient = 598.2

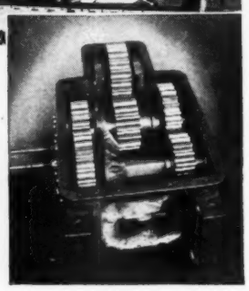
24 hour coefficient = 14356.8

IN THE NEWS
WITH BANTAM BEARINGS

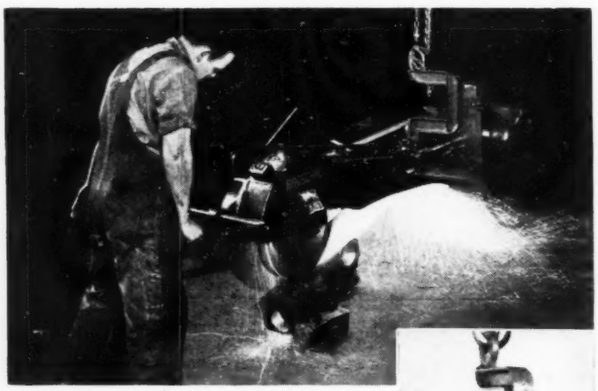
STRIKING POWER! Somewhere in the Pacific, U.S. Aircraft Carriers are seeking the enemy, looking for the chance to "dish-it-out." Back in South Bend, Indiana, other men and women—fathers, uncles, sisters, friends of the boys on the fighting fronts—are "dishing-it-out" too. That's why everyone of us at Bantam is proud of our third award of merit, the Army-Navy E flag with Two Stars. We're proud too, to have Bantam Bearings serving on nearly every type of fighting ship in the U. S. Navy.



1800 TIMES PER HOUR *a thrust load* is exerted on this Rotary Hammer-type Riveter designed and built by The Grant Mfg. & Machine Co. Bantam Ball Thrust Bearings are used to carry the thrust load between the mainshaft bearing and inner clutch plate as well as the thrust of the mainshaft at point shown in the photo between the spindle pulley and the frame. Because Bantam's line includes all major types of anti-friction bearings Bantam's engineers are in a position to give experienced help and counsel in the design and selection of bearings for any type of job.



THIS SIX-TON "MOBILCRANE" does the job whenever and *wherever* needed. Built by the Osgood Company it operates and travels on a single power unit. In the design of the wheel drive power transmission, shown in close-up, Bantam Quill Bearings support one end of the transmission shafts which operate at 290 to 660 R.P.M. under heavy load—especially when operating in low gear. This interesting application utilizes the compact design and high capacity of Bantam's Quill Bearing. Additional information will be found in our Catalog. Write for your copy of Bulletin P-104.



SWING IT! For grinding large castings, take grinder to the job. That is an outstanding advantage of the swing frame grinder manufactured by the Vonnegut Moulder Corporation. And the "swing frame" (see inset) which holds the grinder chassis turns on a Bantam Quill Bearing to insure freedom of movement and ease of control in manual operation. This is another application where Bantam Quill Bearings are helping industry-at-war "beat the promise."

IF YOU'RE IN WAR WORK and need anti-friction bearings for any type of job TURN TO BANTAM. The Bantam line includes every major type of bearing—straight roller, tapered roller, needle and ball. Our engineers will be glad to work with yours in meeting today's needs and planning tomorrow's designs. Call us if we may be of help on any type of anti-friction bearing problem.

BANTAM BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

MECHANICAL AND PHYSICAL PROPERTIES OF A.P.I. STANDARD DRILL PIPE

Size outside diameter D	Inside diameter	Wall thickness t	Weight per foot		Area of metal, plain end, sq. in.	Moment of inertia	Section modulus	Radius of gyration	Polar moment of inertia	Polar section modulus	Tensile pull						Torsional yield strength	
											Grade D			Grade E				
			Calculated plain end	Nominal threads and coupling							Yield strength	Ultimate strength		Yield strength	Ultimate strength		Grade D	Grade E
											0.9×min.	Min.	Ave.	0.9×min.	Min.	Ave.		
In.	In.	In.	Lb.	Lb.	A	I	S=I/Y	R=√I/A	J=2I	Z=2S	1000 lb.			1000 lb.			in.-lb.	
2⅜	1.815	0.280	6.26	6.65	1.8429	1.029	0.867	0.747	2.058	1.734	91	175	184	124	184	203	52450	76300
2⅞	2.151	0.362	9.72	10.40	2.8579	2.303	1.602	0.898	4.606	3.204	141	272	286	193	286	314	96920	140980
3½	2.764	0.368	12.31	13.30	3.6209	4.502	2.573	1.115	9.004	5.146	179	344	362	244	362	398	155670	226420
3½	2.602	0.449	14.63	15.50	4.3037	5.117	2.924	1.090	10.234	5.848	213	409	430	290	430	473	176900	257310
*4	3.340	0.330	12.93	14.00	3.8048	6.459	3.230	1.303	12.918	6.460	188	361	380	257	380	419	195420	284240
*4	3.240	0.380	14.69	15.70	4.3216	7.159	3.580	1.287	14.318	7.160	214	411	432	292	432	475	216590	315040
4½	3.826	0.337	14.98	16.60	4.4074	9.613	4.272	1.477	19.226	8.544	218	419	441	297	441	485	258460	375940
5⅜	4.859	0.352	19.59	22.20	5.7625	19.656	7.067	1.846	39.312	14.134	285	547	576	389	576	634	427550	621900
5⅜	4.733	0.415	22.82	25.25	6.7118	22.386	8.048	1.826	44.772	16.096	332	638	671	453	671	738	486900	708220
6⅝	5.965	0.330	22.19	25.20	6.5262	32.424	9.788	2.229	64.848	19.576	323	620	653	441	653	718	592170	861340

*4-in. size not standard.

Table supplied by National Tube Co., Products Engineering Department.

From the largest oil field in Texas

PRODUCING BELOW 10,000 FEET

A major operator reports:

"In this field, Old Ocean, we have made over 150 successful squeeze jobs below 10,000 feet with Unaflo. Average closing of truck pressure 4500 lbs. With bottom hole temperature 230°F."

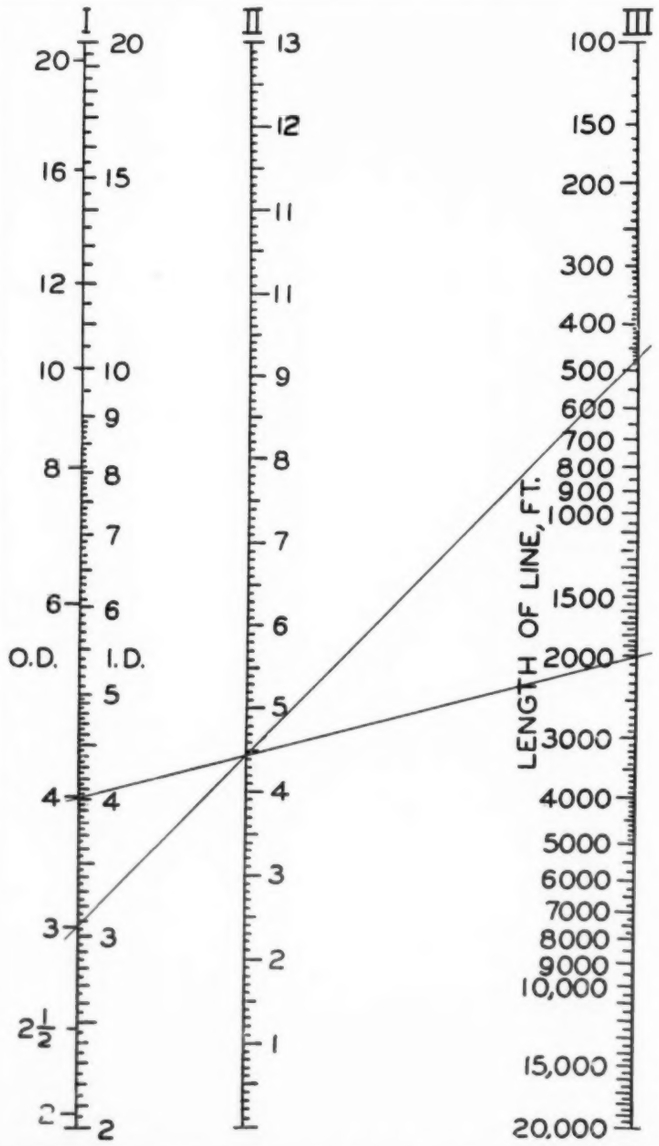
IT IS not only spectacular cementing jobs that prove the full value of Unaflo cement. Rather, it is the consistent, day-to-day, dependable performance of this cement with the retarded set which has earned its high reputation among oil men. *Improved* Unaflo, developed after years of research and testing in the laboratory, in the plant and in the field, has advantages which assure greater cementing economy and safer, better cementing on all kinds of jobs. Ask your dealer for *Improved* Unaflo. Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Amicable Building, Waco; Oklahoma City; Kansas City; Chicago; Birmingham.

PE-U-31

IMPROVED UNAFLO

PRODUCT OF UNIVERSAL ATLAS CEMENT COMPANY

SOLUTION OF COMPLEX PIPE LINE FORMULAS FOR GAS FLOW



The alignment chart on the left was constructed from the following formula:

$$L_1 = L_2\left(\frac{L_1}{L_2}\right)^{\frac{5}{16}}$$

Where:

L = length of the line in ft. and

d = diameter of the pipe in in.

Problem: What length of 4-in. diameter pipe will have the same pressure drop as 480 ft. of 3-in. diameter pipe?

Solution: Draw a straight line from the 3-in. pipe diameter on column I to 480 ft. length on column III. The line will intersect column II at 4.45. Then draw a straight line from the 4-in. diameter pipe on column I through 4.45 on column II which will intersect column III at 2000. The length of 4-in. pipe that will have the same pressure drop as 480 ft. of 3-in. pipe is 2000 ft.

In solving similar problems on this chart either internal diameter or external diameter may be used, although care must be taken to use one or the other for both pipes.

The alignment chart on the right side of the page was made from the following formula:

$$d_1 = d_2\left(\frac{d_1}{d_2}\right)^{5.33}$$

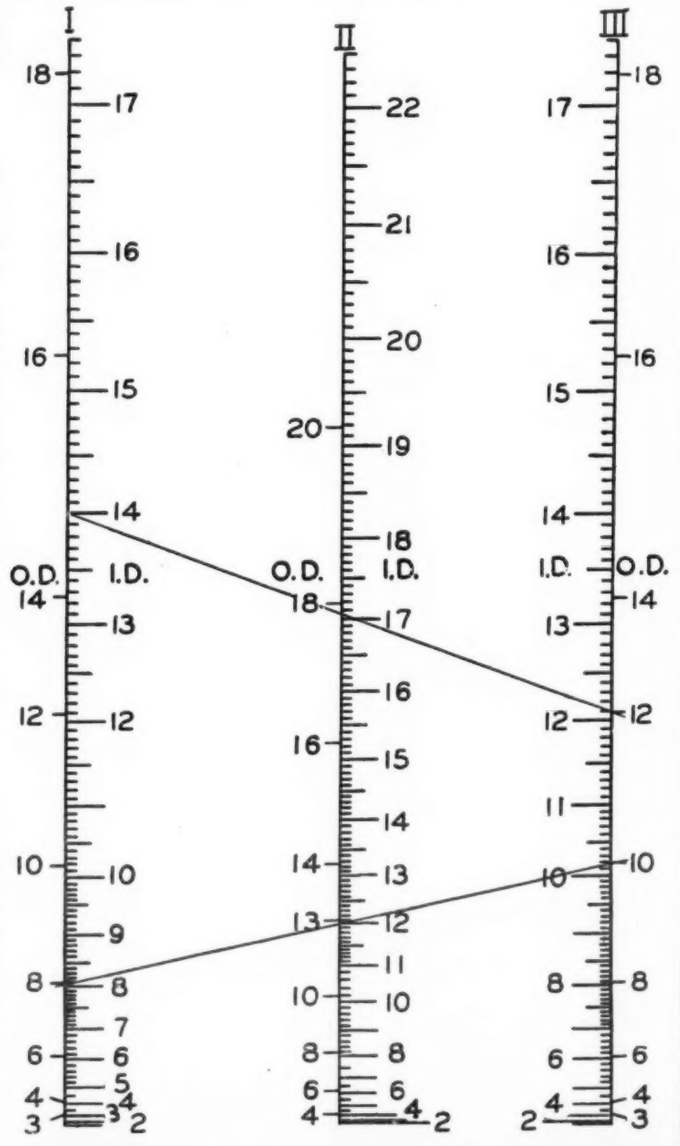
Where:

L = length of the line in ft. and

d = diameter of the pipe in in.

Problem: If an 8-in. and 10-in. external diameter pipe line parallel each other and are connected at each end, what size pipe would have the same capacity as both. (Note: Both sides of the looped lines must be the same length.)

Solution: Draw a straight line from 8 on Column I to 10 on column III. The line will intersect column II at 13, which is the external diameter of a single pipe of equivalent capacity of the 8- and 10-in. lines.



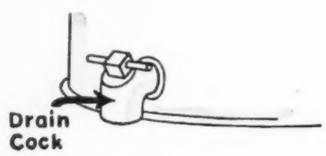
P 622.4

How to make Acetylene Generators last longer and work more efficiently...

Acetylene generators are a convenient and economical source of acetylene gas for use in the oxy-acetylene process. When operated and maintained in accordance with the manufacturer's instructions, a good generator should function safely and efficiently indefinitely. A few suggestions are outlined here to help you keep your generator working its best for a long time.

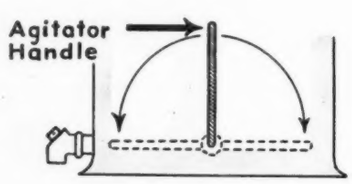
WHEN RECHARGING

1. ***Always change the water*** whenever a generator is to be recharged, and replace it with clean, cool, water. This will



guard against a rise in temperature within the generator to an abnormal level that would affect the safety and efficiency of operation.

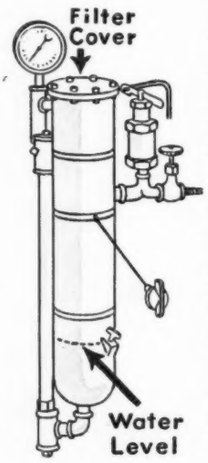
2. ***Operate the residue agitator*** while draining the generating chamber. This



will help assure thorough removal of the residue.

3. ***Flush the generating chamber*** with clean water after draining off all the residue. If this is not done, the lime deposit will build up so that the amount of water that can be put into the generating chamber is considerably reduced. In addition, the caked deposit will make difficult operation of the residue agitator, and will slow up recharging by partially plugging the drain cock.

4. ***Check the hydraulic*** water level each time the generator is recharged, and add water to the correct level if needed. This is important to assure protection to the generator in case of a flashback of flame.



MAINTENANCE SUGGESTIONS

5. ***Clean filter pads*** should be installed at regular intervals. This is necessary not only because dirty pads may restrict the flow of acetylene, but also because they permit entrained moisture and small particles of lime to be carried over into the hose and apparatus.

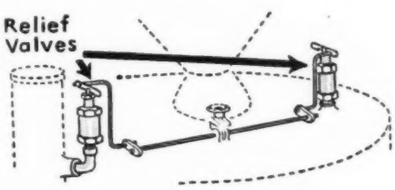
6. ***Test for leaks*** with soapy water at periodic intervals, particularly around gaskets—and always immediately after a gasket has been replaced. This is important not only because leaks represent a serious hazard, but also because gas leaks are costly.

7. ***Prevent rust*** on the outside of the generator by painting it or touching up bare spots whenever needed.

FOR SAFETY'S SAKE

8. ***Prevent freezing*** of water in any part of the generator, as freezing may destroy its usefulness and will in many cases present serious hazards. The book illustrated here will help you to do this. Copies may be obtained from any Linde Office, without charge.

9. ***Relief valves*** should be kept in good operating condition at all times, and set



to release at the pressures recommended by the manufacturer.

10. ***Do not remove*** permanently any part of the generator mechanism. Each part is specifically designed to help assure safe and efficient operation.

11. ***Follow all instructions*** furnished with the generator. Duplicate instruction books for all Oxweld generators can be obtained from any Linde office without charge.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York, N. Y. UCC Offices in Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

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The words "Linde," and "Oxweld" are trademarks.

Static Press.
3100-3195 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																			
	3100	3105	3110	3115	3120	3125	3130	3135	3140	3145	3150	3155	3160	3165	3170	3175	3180	3185	3190	3195
2	78.91	78.99	79.04	79.11	79.17	79.24	79.30	79.35	79.42	79.48	79.54	79.61	79.68	79.74	79.81	79.86	79.92	79.99	80.05	80.12
4	111.6	111.7	111.8	111.9	112.0	112.1	112.2	112.2	112.3	112.4	112.5	112.6	112.7	112.8	112.9	113.0	113.1	113.2	113.3	113.4
6	136.7	136.8	136.9	137.0	137.1	137.2	137.3	137.4	137.5	137.6	137.7	137.8	138.0	138.1	138.2	138.3	138.4	138.5	138.6	138.7
8	157.8	157.9	158.1	158.2	158.3	158.5	158.6	158.7	158.8	158.9	159.1	159.2	159.4	159.5	159.6	159.7	159.8	159.9	160.1	160.2
10	176.5	176.6	176.7	176.9	177.0	177.2	177.3	177.5	177.6	177.7	177.9	178.0	178.2	178.3	178.5	178.6	178.7	178.9	179.0	179.2
12	193.3	193.5	193.6	193.8	193.9	194.1	194.3	194.4	194.6	194.7	194.8	195.0	195.2	195.3	195.5	195.6	195.8	195.9	196.1	196.3
14	208.8	209.0	209.2	209.4	209.5	209.7	209.9	210.0	210.2	210.3	210.5	210.7	210.9	211.0	211.2	211.3	211.5	221.7	211.8	212.0
16	223.2	223.4	223.6	223.8	223.9	224.2	224.3	224.5	224.7	224.8	225.0	225.2	225.4	225.6	225.8	225.9	226.1	226.3	226.4	226.6
18	236.8	237.0	237.2	237.4	237.6	237.8	237.9	238.1	238.3	238.5	238.7	238.8	239.1	239.3	239.5	239.6	239.8	240.0	240.2	240.4
20	249.6	249.8	249.9	250.2	250.4	250.6	250.8	250.9	251.2	251.4	251.6	251.8	251.9	252.2	252.4	252.6	252.8	252.9	253.2	253.4
21	255.8	256.0	256.2	256.4	256.6	256.8	257.0	257.2	257.4	257.6	257.8	258.0	258.3	258.4	258.7	258.8	259.0	259.3	259.4	259.7
22	261.7	261.9	262.2	262.4	262.6	262.8	263.0	263.2	263.4	263.6	263.8	264.0	264.3	264.5	264.7	264.9	265.1	265.3	265.5	265.7
23	267.7	267.9	268.1	268.3	268.5	268.8	268.9	269.2	269.4	269.6	269.8	270.0	270.3	270.4	270.7	270.9	271.1	271.3	271.5	271.7
24	273.4	273.6	273.9	274.1	274.3	274.5	274.7	274.9	275.2	275.4	275.6	275.8	276.1	276.3	276.5	276.7	276.9	277.1	277.3	277.6
25	279.1	279.3	279.5	279.8	279.9	280.2	280.4	280.6	280.9	281.1	281.3	281.5	281.7	281.9	282.2	282.4	282.6	282.9	283.1	283.3
26	284.6	284.8	285.0	285.3	285.5	285.7	285.9	286.2	286.4	286.6	286.8	287.1	287.3	287.5	287.8	287.9	288.2	288.5	288.7	288.9
27	289.9	290.2	290.4	290.7	290.9	291.2	291.4	291.6	291.9	292.1	292.3	292.5	292.8	293.0	293.3	293.5	293.7	293.9	294.1	294.4
28	295.3	295.6	295.8	296.1	296.3	296.6	296.8	296.9	297.3	297.5	297.8	297.9	298.2	298.4	298.7	298.9	299.1	299.4	299.6	299.8
29	300.5	300.8	301.0	301.3	301.5	301.8	301.9	302.2	302.5	302.7	302.9	303.2	303.4	303.7	303.9	304.1	304.4	304.6	304.8	305.1
30	305.7	305.9	306.2	306.4	306.7	306.9	307.2	307.4	307.6	307.9	308.1	308.4	308.6	308.8	309.1	309.3	309.6	309.8	310.1	310.3
31	310.8	311.0	311.3	311.5	311.8	312.0	312.3	312.5	312.8	312.9	313.2	313.5	313.8	313.9	314.3	314.5	314.7	314.9	315.2	315.5
32	315.7	316.0	316.2	316.5	316.7	317.0	317.2	317.5	317.8	317.9	318.2	318.5	318.8	318.9	319.3	319.5	319.7	320.0	320.2	320.5
33	320.6	320.9	321.1	321.4	321.7	321.9	322.2	322.4	322.7	322.9	323.2	323.4	323.7	323.9	324.3	324.5	324.7	324.9	325.2	325.5
34	325.4	325.7	325.9	326.2	326.5	326.8	327.0	327.2	327.5	327.8	327.9	328.3	328.6	328.8	329.1	329.3	329.6	329.9	330.1	330.4
35	330.2	330.5	330.7	331.0	331.2	331.5	331.8	332.0	332.3	332.5	332.8	333.1	333.4	333.6	333.9	334.1	334.4	334.7	334.9	335.2
36	334.9	335.2	335.4	335.7	335.9	336.2	336.5	336.7	337.0	337.3	337.5	337.8	338.1	338.3	338.6	338.9	339.1	339.4	339.7	339.9
37	339.5	339.8	340.0	340.3	340.6	340.9	341.1	341.4	341.7	341.9	342.2	342.5	342.8	343.0	343.3	343.6	343.8	344.1	344.4	344.7
38	344.0	344.3	344.6	344.9	345.1	345.4	345.7	345.9	346.2	346.5	346.7	347.0	347.3	347.6	347.9	348.1	348.4	348.7	348.9	349.3
39	348.5	348.8	349.1	349.4	349.7	349.9	350.2	350.5	350.8	351.0	351.3	351.6	351.9	352.2	352.5	352.7	352.9	353.3	253.5	353.8
40	352.9	353.3	353.6	353.9	354.1	354.5	354.7	354.9	355.3	355.5	355.8	356.1	356.4	356.7	356.9	357.2	357.5	357.8	358.1	358.4
41	357.4	357.7	357.9	358.2	358.5	358.8	359.1	359.3	359.7	359.9	360.2	360.5	360.8	361.1	361.4	361.6	361.9	362.2	362.5	362.8
42	361.7	362.0	362.3	362.6	362.9	363.2	363.5	363.7	364.0	364.3	364.6	364.9	365.2	365.5	365.8	366.0	366.3	366.6	366.9	367.2
43	365.9	366.3	366.5	366.9	367.1	367.5	367.7	367.9	368.3	368.6	368.8	369.1	369.5	369.7	370.1	370.3	370.6	370.9	371.2	371.5
44	370.2	370.5	370.8	371.1	371.4	371.7	371.9	372.2	372.6	372.8	373.1	373.4	373.8	374.0	374.4	374.6	374.9	375.2	375.5	375.8
45	374.4	374.7	374.9	375.3	375.6	375.9	376.2	376.5	376.8	377.1	377.3	377.7	377.9	378:3	378.6	378.9	379.1	379.5	379.7	380.1
46	378.5	378.8	379.1	379.5	379.7	380.1	380.3	380.6	380.9	381.2	381.5	381.8	382.2	382.4	382.8	383.0	383.3	383.7	383.9	384.3
47	382.6	382.9	383.3	383.6	383.9	384.2	384.5	384.8	385.1	385.4	385.7	385.9	386.3	386.6	386.9	387.2	387.5	387.8	388.1	388.5
48	386.7	386.9	387.3	387.6	387.9	388.2	388.5	388.8	389.1	389.4	389.7	390.0	390.4	390.7	391.0	391.3	391.6	391.9	392.2	392.5
49	390.7	391.0	391.3	391.7	391.9	392.3	392.6	392.8	393.2	393.5	393.8	394.1	394.5	394.7	395.1	395.4	395.6	395.9	396.3	396.6
50	394.6	394.9	395.3	395.6	395.9	396.3	396.5	396.8	397.2	397.5	397.9	398.1	398.5	398.7	399.1	399.4	399.7	400.0	400.3	400.6
51	398.5	398.9	399.2	399.5	399.8	400.2	400.5	400.8	401.1	401.4	401.7	402.0	402.4	402.7	403.0	403.3	403.6	403.9	404.3	404.6
52	402.4	402.8	403.1	403.5	403.7	404.1	404.5	404.7	405.0	405.3	405.6	405.9	406.3	406.6	406.9	407.3	407.6	407.9	408.2	408.6
53	406.3	406.7	406.9	407.3	407.6	407.9	408.3	408.6	408.9	409.2	409.5	409.9	410.2	410.5	410.9	411.2	411.5	411.8	412.1	412.5
54	410.1	410.5	410.8	411.1	411.4	411.8	412.1	412.4	412.7	413.0	413.3	413.7	414.1	414.4	414.7	415.0	415.3	415.7	415.9	416.3
55	413.9	414.3	414.6	414.9	415.2	415.6	415.9	416.2	416.6	416.9	417.2	417.5	417.9	418.2	418.6	418.9	419.2	419.5	419.8	420.2
56	417.6	418.0	418.3	418.7	418.9	419.3	419.6	419.9	420.3	420.6	420.9	421.3	421.7	421.9	422.3	422.6	422.9	423.3	423.6	423.9
57	421.4	421.7	422.0	422.4	422.7	423.1	423.4	423.7	424.1	424.4	424.7	425.1	425.4	425.7	426.1	426.4	426.7	427.1	427.4	427.8
58	425.0	425.4	425.7	426.1	426.4	426.8	427.1	427.4	427.8	428.1	428.4	428.8	429.2	429.5	429.8	430.2	430.5	430.8	431.1	431.5
59	428.7	429.1	429.4	429.8	430.1	430.4	430.8	431.1	431.4	431.7	432.1	432.4	432.8	433.1	433.5	433.8	434.1	434.5	434.8	435.2
60	432.3	432.7	433.0	433.4	433.7	434.1	434.4	434.7	435.1	435.4	435.7	436.1	436.5	436.8	437.2	437.5	437.8	438.2	438.5	438.9
61	435.9	436.3	436.6	436.9	437.3	437.7	437.9	438.3	438.7	439.0	439.3	439.7	440.1	440.4	440.8	441.1	441.4	441.8	442.1	442.5
62	439.4	439.8	440.2	440.6	440.9	441.3	441.6	441.9	442.3	442.6	442.9	443.3	443.7	444.0	444.4	444.7	445.0	445.4	445.7	446.1
63	442.9	443.3	443.7	444.1	444.4	444.8	445.1	445.4	445.8	446.1	446.5	446.9	447.2	447.6	447.9	448.3	448.6	448.9	449.3	449.7
64	446.5	446.9	447.2	447.6	447.9	448.3	448.6	448.9	449.4	449.7	450.0	450.4	450.8	451.1	451.5	451.8	452.2	452.6	452.9	453.3
65	449.9	450.3	450.7	451.1	451.4	451.8	452.1	452.4	452.8	453.2	453.5	453.9	454.3	454.6	455.0	455.3	455.7	456.1	456.4	456.8
66	453.4	453.8	454.1	454.5	454.9	455.3	455.6	455.9	456.3	456.7	456.9	457.4	457.8	458.1	458.5	458.8	459.2	459.6	459.9	460.3
67	456.8	457.2	457.5	457.9	458.3	458.7	459.0	459.3	459.8	460.1	460.4	460.8	461.2	461.6	461.9	462.3	462.6	463.0	463.4	463.8
68	460.2	460.6	460.9	461.4	461.7	462.1	462.4	462.8	463.2	463.5	463.8	464.2	464.7	464.9	465.4	465.7	466.1	466.5	466.8	467.2
69	463.6	464.0	464.4	464.8	465.1	465.5	465.9	466.2	466.6	466.9	467.3	467.7	468.1	468.4	468.8	469.2	469.5	469.9	470.3	470.7
70	466.9	467.4	467.9	468.1	468.5	468.9	469.2	469.6	469.9	470.3	470.6	471.1	471.5	471.8	472.2	472.6	472.9	473.3	473.7	474.1
71	470.3	470.7	471.0	471.4	471.8	472.2	472.5	472.9	473.3	473.6	473.9	474.4	474.8	475.1	475.6	475.9	476.2	476.7	476.9	477.4
72	473.5	473.9	474.3	474.7	475.0	475.4	475.8	476.1	476.5	476.9	477.2	477.6	478.1	478.4	478.8	479.2	479.5	479.9	480.3	480.7
73	476.8	477.3	477.6	478.0	478.4	478.8	479.1	479.5	479.9	480.3	480.6	481.0	481.5	481.8	482.2	482.6	482.9	483.3	483.7	484.1
74	480.1	480.5	480.9	481.3	481.6	482.1	482.4	482.7	483.2	483.5	483.9	484.3	484.7	485.1	485.5	485.8	486.2	486.6	486.9	487.4
75	483.3	483.7	484.1	484.5	484.9	485.3	485.7	485.9	486.4	486.8	487.1	487.6	487.9	488.3	488.8	489.1	489.5	489.9	490.2	490.7
76	486.6	486.9	487.3	487.8	488.1	488.6	488.9	489.3	489.7	490.0	490.4	490.8	491.3	491.6	492.0	492.4	492.7	493.2	493.5	493.9
77	489.7	490.2	490.5	490.9	491.3	491.8	492.1	492.5	492.9	493.2	493.6	494.0	494.5	494.8	495.3	495.6	495.9	496.4	496.8	497.2
78	492.9	493.4	493.7	494.2	494.5	494.9	495.3	495.7	496.1	496.4	496.8	497.2	497.7	498.0	498.5	498.8	499.2	499.6	499.9	500.4
79	496.0	496.5	496.8	497.3	497.6	498.1	498.4	498.9	499.2	499.6	499.9	500.4	500.8	501.2	501.6	501.9	502.3	502.8	503.1	503.6
80	499.2	499.6	499.9	500.4	500.8	501.2	501.6	501.9	502.4	502.7	503.1	503.5	503.9	504.4	504.8	505.2	505.5	505.9	506.3	506.8
82	505.4	505.8	506.2	506.6	506.9	507.4	507.8	508.2	508.6	508.9	509.3	509.8	510.2	510.6	511.1	511.4	511.8	512.2	512.6	513.0
84	511.5	511.9	512.3	512.8	513.1	513.6	513.9	514.3	514.8	515.2	515.5	515.9	516.4	516.8	517.3	517.6	518.0	518.5	518.8	519.3
86	517.6	518.0	518.4	518.9	519.3	519.7	520.1	520.5	520.9	521.3	521.7	522.1	522.6	522.9	523.4	523.8	524.2	524.6	525.0	525.5
88	523.6	524.0	524.4	524.9	525.2	525.7	526.1	526.5	526.9	527.3	527.7	528.2	528.6	528.9	529.5	529.8	530.2	530.7	531.1	531.5
90	529.5	529.9	530.3	530.8	531.2	531.7	532.0	532.4	532.9	533.3	533.6	534.1	534.6	534.9	535.4	535.8	536.2	536.7	537.1	537.5
92	535.3	535.8	536.2	536.7	537.1	537.5	537.9	538.3	538.8	539.2	539.6	540.0	540.5	540.9	541.4	541.8	542.1	542.6	543.0	543.5
94	541.1	541.6	541.9	542.4	542.8	543.3	543.7	544.1	544.6	544.9	545.3	545.8	546.3	546.7	547.2	547.6	547.9	548.3	548.8	549.3
96	546.8	547.3	547.7	548.2	548.6	549.1	549.5	549.9	550.4	550.7	551.1	551.6	552.1	552.5	552.9	553.4	553.8	554.2	554.7	555.2
98	552.5	552.9	553.4	553.8	554.2	554.7	555.1	555.5	556.0	556.4	556.8	557.3	557.8	558.2	558.7	559.1	559.5	559.9	560.4	560.9
100	558.1	558.6	559.0	559.5	559.9	560.4	560.8	561.2	561.7	562.1	562.5	563.0	563.5	563.9	564.4	564.8	565.2	565.7	566.1	566.6

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water, respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

You get long hard service—
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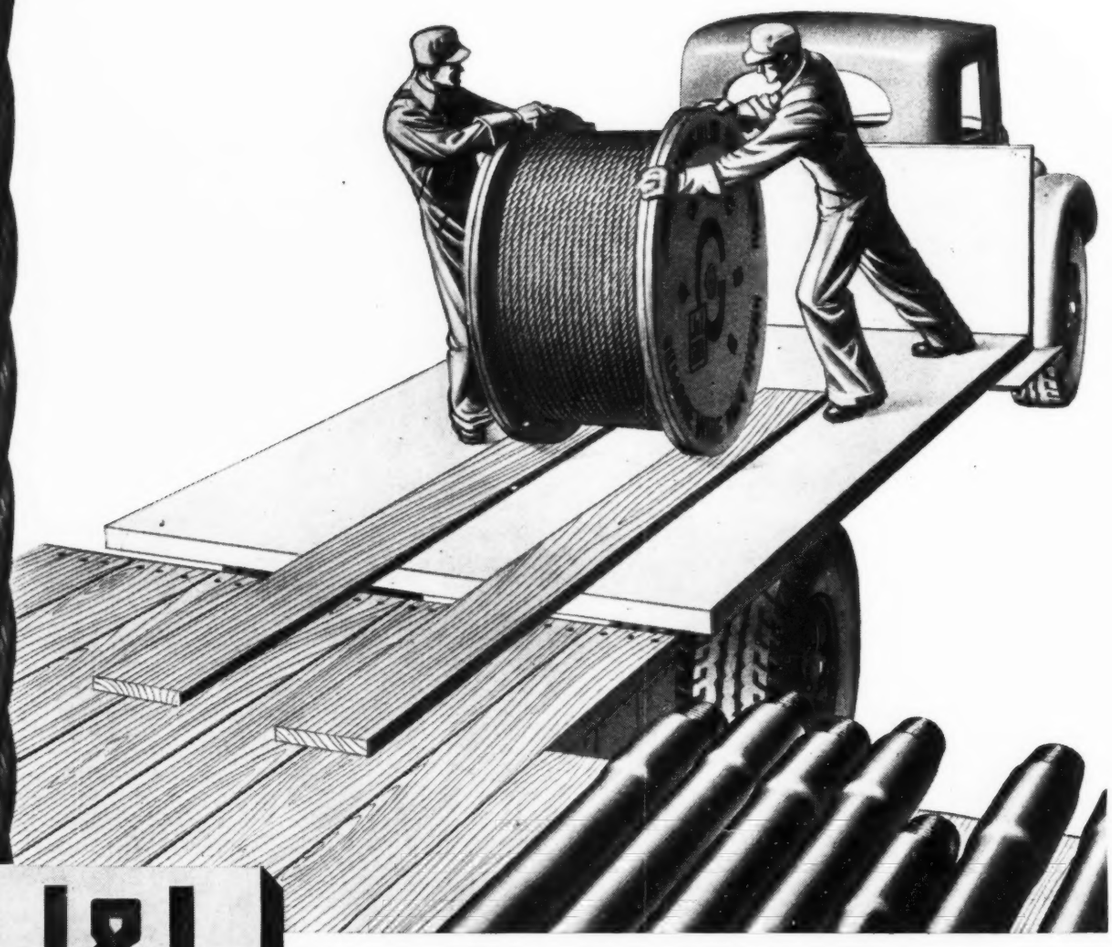
WIRE ROPE



J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
GILMORE WIRE ROPE DIVISION, PITTSBURGH & MUNCY, PENNSYLVANIA

J&L OIL COUNTRY PRODUCTS
SEAMLESS TUBING • CASING • J&L INTEGRAL-JOINT DRILL PIPE
LINE PIPE • WIRE ROPE

J&L—PARTNER IN PRODUCTION TO INDUSTRY AND DEFENSE

SOLUTION OF OLIPHANT'S FORMULA FOR GAS FLOW IN VACUUM AND PRESSURE LINES FOR GASOLINE PLANTS

Q = discharge cu. ft. per day $Q = 1008\ (A)$

A = function of diameter in in.

$$= D^{5/2} + \frac{D^3}{30}$$

$$\sqrt{\frac{P_1^2 - P_2^2}{L}} \sqrt{\frac{0.6}{G}}$$

P_1 = initial pressure } lb. per sq. in. abs.
P_2 = final pressure }

L = length (miles)

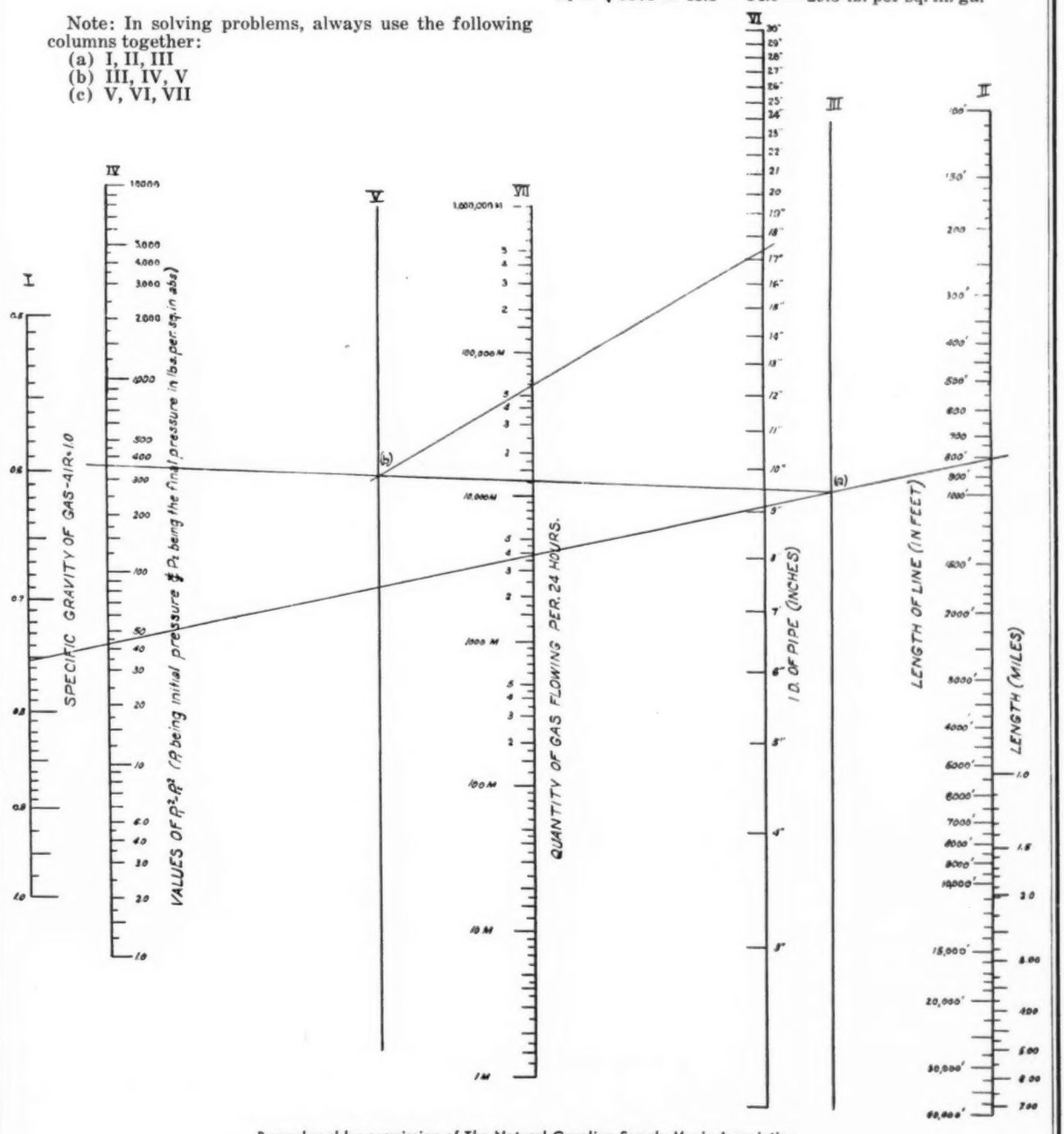
G = specific gravity of gas, air = 1

Problem: $L = 800$ ft., $G = 0.75$, and internal diameter of 18 in. pipe = 17.25 in.
$Q = 60{,}000{,}000$, and $P_2 = 25$ lb. gauge.

Required: P_1

Solution: Connect straight line through 0.75 on I and through 800 ft. on II, locating (a) on III.
Connect straight line through 17.25 on VI and through 60,000 M on VII, locating (b) on V.
Connect straight line through (a) and (b) to IV and find $P_1^2 - P_2^2 = 350$.
But $P_2 = 25$ lb. gauge or $25 + 14 = 39$ lb. in. abs.
$P_1^2 - P_2^2 = 350$
$P_1^2 = 350 + (39)^2 = 350 + 1521 = 1871$
$P_1 = \sqrt{1871} = 43.3 - 14.0 = 29.3$-lb. per sq. in. ga.

Note: In solving problems, always use the following columns together:
(a) I, II, III
(b) III, IV, V
(c) V, VI, VII



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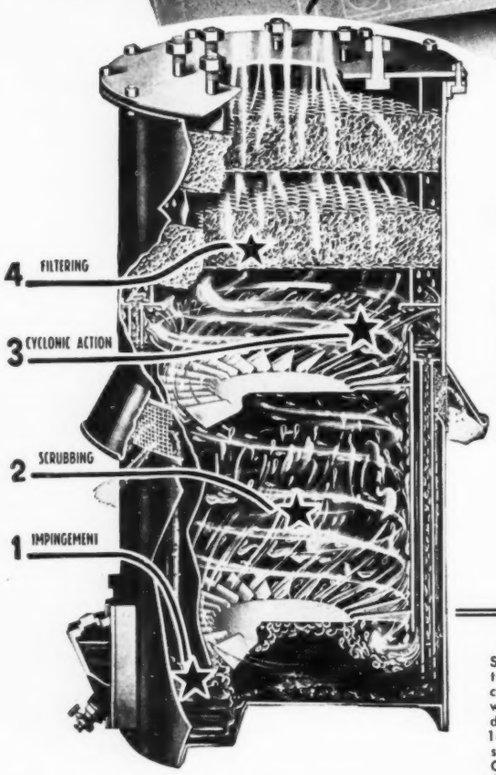
Don't Overlook the Importance of the RIGHT AIR FILTERS!



Write for Cycoil Bulletin No. 130D, which gives complete information on the operation of the Cycoil.

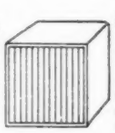
CARE WILL SAVE YOUR ENGINES AND COMPRESSORS

It pays to protect the precious machinery and power plants that make possible the production of arms and equipment for our fighting forces. Production schedules, accelerated many times normal, have doubled or trebled the running time of gas engines, diesels and compressors in use throughout the nation, which means that clean air is more vital to their operation today than at any previous time. AAF offers a complete line of air cleaning equipment for engine and compressor service. Write for free descriptive bulletins. There is no obligation.

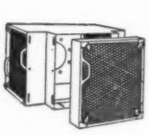
AMERICAN AIR FILTER CO., INC.
Incorporated
384 Central Avenue, Louisville, Kentucky
***In Canada:* Darling Bros., Ltd., Montreal, P. Q.**

CYCOIL GAS CLEANER
Suitable for practically every gas cleaning problem when temperatures do not exceed 140°F. Operates on same principle as Cycoil Oil Bath Air Cleaner. Ask for Bulletin 130D.

PL-H FILTER
is a complete assembly consisting of housing, ready to bolt to intake pipe, and dry cell type filters in which wool felt constitutes the filter medium. Ask for Bulletin 120D.



TYPE OCH FILTER
Complete assembly consisting of washable viscous impingement type filters. 1, 2, 3, or more cells are used, depending upon size of cleaning job. Ask for Bulletin 120D.



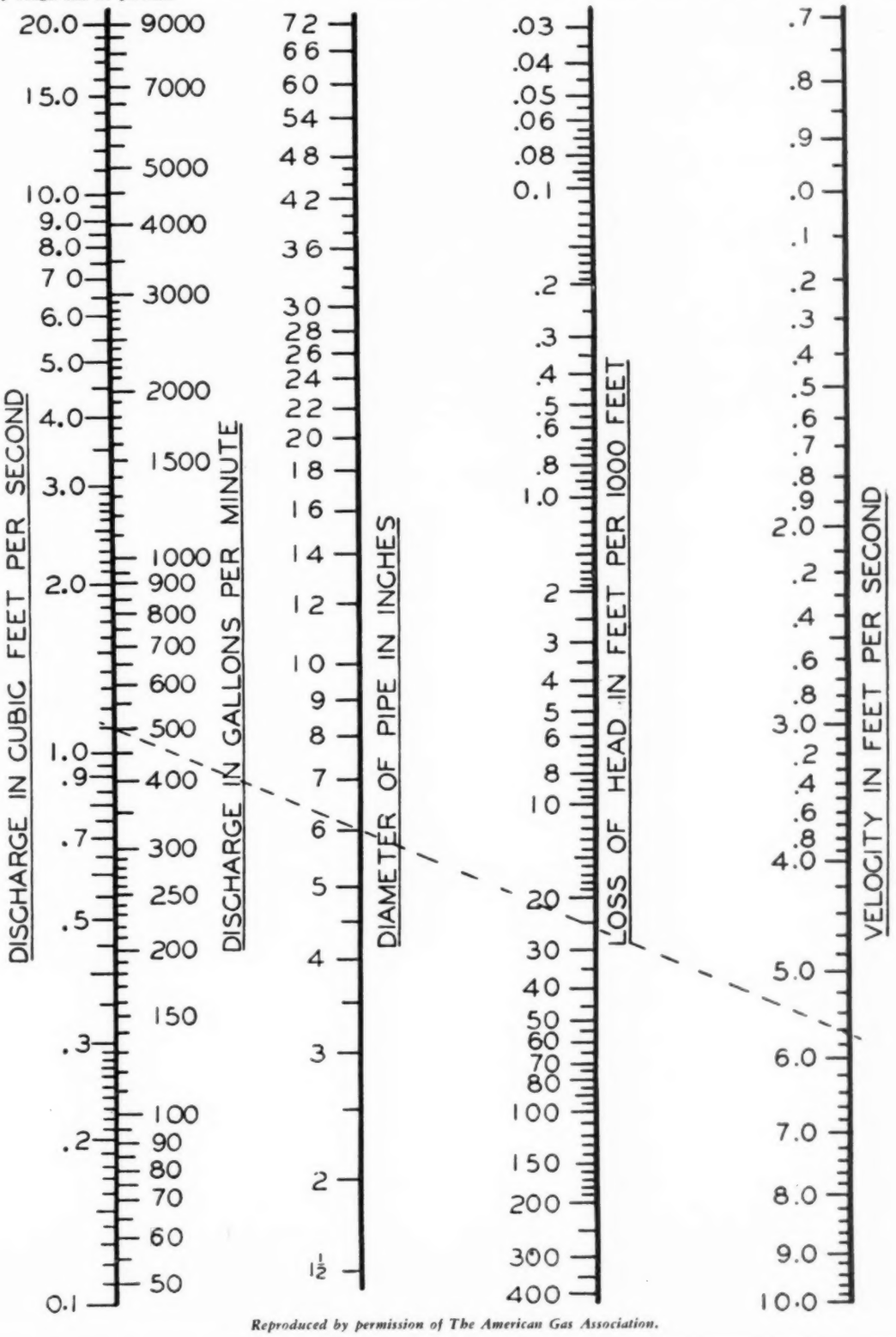
AMERICAN *Cycoil* AIR and GAS CLEANERS

CALCULATION OF PIPE SIZES, DISCHARGE VELOCITIES, AND LOSS OF HEAD

Procedure: Lay a rule on scales at the points of any two known quantities and the unknown quantities will lie at the intersection of the edge of the rule with the other scales.

Example: To discharge 500 gal. per min. through 6-in. pipe, there will be 25 ft. head loss per 1000 ft. and a velocity of 5.7 ft. per sec.

Note: Multiply loss of head in cast iron pipe by 1½; in concrete by 2. When pipe is somewhat rough add 10 percent to loss of head and when very rough add 25 percent.



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SAYS THE MAN who knows his bearings, "because heavy loads are taken in stride by high-capacity Hyatt Hy-Load Roller Bearings."

That's why, in America's drive for more and more production... with machinery geared up to punishing speeds you'll find Hyatts carrying the load. And in the Tanks... Trucks... Guns... Ships... Planes, which these machines build, Hyatts are also serving.

Yes, the men who know their bearings say, "I'll take the Hyatt Hy-Load Bearing for tough jobs." And to back up their judgment are fifty years of Hyatt application in all types of industrial, automotive, and farm equipment... without ever letting the builders down.

Nor will they let Uncle Sam down for, as they guard the machines that run farms and factories, they also carry the bearing loads of the machines that fight.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

THE 50TH YEAR OF HYATT ROLLER BEARINGS

PREHEATING CHART FOR WELDING

Metal group	Metal designation	Approximate composition, percent								Metal designation	Recommended preheat
		C.	Mn.	Si.	Cr.	Ni.	Mo.	Cu.			
Plain carbon steels	Plain carbon steel	below. 20								Plain carbon steel	Up to 200°F.
	Plain carbon steel	.20-.30								Plain carbon steel	200°F.-300°F.
	Plain carbon steel	.30-.45								Plain carbon steel	300°F.-500°F.
	Plain carbon steel	.45-.80								Plain carbon steel	500°F.-800°F.
Carbon moly steels	Carbon moly steel	10-.20					.50			Carbon moly steel	300°F.-500°F.
	Carbon moly steels	.20-.30					.50			Carbon moly steel	400°F.-600°F.
	Carbon moly steel	.30-.35					.50			Carbon moly steel	500°F.-800°F.
Manganese steels	Silicon structural steel	.35	.80	.25						Silicon structural steel	300°F.-500°F.
	Medium manganese steel	.20-.25	1.0-1.75							Medium manganese steel	300°F.-500°F.
	SAE T 1330 steel	.30	1.75							SAE T 1330 steel	400°F.-600°F.
	SAE T 1340 steel	.40	1.75							SAE T 1340 steel	500°F.-800°F.
	SAE T 1350 steel	.50	1.75							SAE T 1350 steel	600°F.-900°F.
	12 percent manganese steel	1.25	12.0							12 percent manganese steel	usually not req'd
High tensile steels (See also steels below)	Manganese moly steel	.20	1.65	.20			.35			Manganese moly steel	300°F.-500°F.
	Jalten steel	.35 max.	1.50	.30				.40		Jalten steel	400°F.-600°F.
	Manten steel	.30 max.	1.35	.30				.20		Manten steel	400°F.-600°F.
	Armco high tensile steel	.12 max.				.50 min.	.05 min.	.35 min.		Armco high tensile steel	Up to 200°F.
	Double strength No. 1 steel	.12 max.	.75			.50-1.25	.10 min.	.50-1.50		Double strength No. 1 steel	300°F.-600°F.
	Double strength No. 1A steel	.30 max.	.75			.50-1.25	.10 min.	.50-1.50		Double strength No. 1A steel	400°F.-700°F.
	Mayari R steel	.12 max.	.75	.35	.2-1.0	.25-.75		.60		Mayari R steel	Up to 300°F.
	Otiscoloy steel	12 max.	1.25	.10 max.	.10 max.			.50 max.		Otiscoloy steel	200°F.-400°F.
	Nax high tensile steel	.15-.25		.75	.60	.17	.15 max.	.25 max.	Zr. .12	Nax high tensile steel	Up to 300°F.
	Cromansil steel	.14 max.	1.25	.75	.50					Cromansil steel	300°F.-400°F.
	A. W. Dyn-el steel	.11-.14						.40		A. W. Dyn-el steel	Up to 300°F.
	Corten steel	.12 max.		.25-1.0	.5-1.5	.55 max.		4.0		Corten steel	200°F.-400°F.
	Chrome copper nickel steel	.12 max.	.75		.75	.75		.55		Chrome copper nickel steel	200°F.-400°F.
	Chrome manganese steel	.40	.90		.40					Chrome manganese steel	400°F.-600°F.
	Yoloy steel	.05-.35	.3-1.0			1.75		1.0		Yoloy steel	200°F.-600°F.
	Hi-steel	.12 max.	.6	.3 max.		.55		.9-1.25		Hi-steel	200°F.-500°F.
Nickel steels	SAE 2015 Steel	.10-.20				.50				SAE 2015 steel	Up to 300°F.
	SAE 2115 steel	.10-.20				1.50				SAE 2115 steel	200°F.-300°F.
	2½ percent nickel steel	.10-.20				2.50				2½ percent nickel steel	200°F.-400°F.
	SAE 2315 Steel	.15				3.50				SAE 2315 steel	200°F.-500°F.
	SAE 2320 steel	.20				3.50				SAE 2320 steel	200°F.-500°F.
	SAE 2330 steel	.30				3.50				SAE 2330 steel	300°F.-600°F.
	SAE 2340 steel	.40				3.50				SAE 2340 steel	400°F.-700°F.

Preheating prior to welding will

1. Eliminate the danger of formation of cracks.
2. Reduce hardness.
3. Reduce distortion.
4. Reduce or prevent shrinkage stresses.

The need for preheating increases as the following factors are changed

1. The larger the mass being welded.
2. The lower the temperature of the pieces being welded.
3. The lower the atmospheric temperature.
4. The smaller the weld rod in diameter.
5. The greater the speed of welding.
6. The higher the carbon content of the steel.
7. The higher the manganese content.
8. The greater the alloy content in air hardening steels.
9. The more the air hardening capacity of the steel.
10. The greater the difference in mass between the two pieces being joined.
11. The more complicated the shape or section of the parts.

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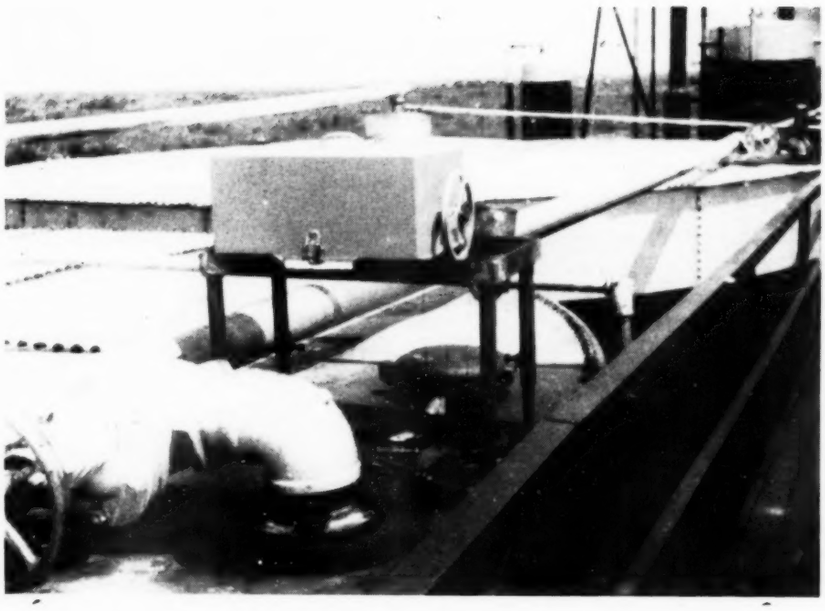


Fig. 1. Recording fluid level gauge in operation on a low 500-bbl. tank, South Eunice Pool, New Mexico

PETROLEUM ENGINEER Exclusive Feature

Application of Recording Fluid Level Gauge to Oil Production

☆Measuring the volume of flow per unit of time

by Leonard C. Halpenny

The Ohio Oil Company

THE petroleum industry has long sought an instrument for measuring continuously the production of oil, including the measurement of daily production, potentials, and rates of flow. The positive displacement fluid meter has been used extensively for measuring daily production. It measures total units of volume without regard to the passage of time but does not give a graphic record. An instrument that measures volume of flow per unit of time has an important field application in the measurement of oil production. Fig. 1 shows such an instrument in operation in the South Eunice Pool, New Mexico.

Applications

In measuring gas-oil ratios, the usual procedure is to obtain a continuous graphic record of the gas produced, and to gauge the oil produced into the lease tank during a 12-hour or a 24-hour period. In many cases the well being tested does not flow at a uniform rate for 12 hours or 24 hours, the ratio of gas produced either increasing or decreasing with respect to the volume of oil produced. A graphic record of oil production in conjunction with a graphic record of gas production will enable the engineer to determine instantaneous values of the gas-oil ratio and to plot a curve of gas-oil ratio versus time, showing the trend of the ratio and indicating whether the test represents a true picture of the average producing ratio.

When a well has been brought-in or worked over, it is generally necessary to measure the potential by gauging production at frequent intervals for a period of 6 to 48 hours. A continuous automatic record of production will eliminate the necessity of having a man remain at the tanks, and the curve produced will indicate the peak rate of flow as well as the steady rate of flow obtained after conditions have become constant. The curve will also indicate the length of time required to reach constant rate of flow.

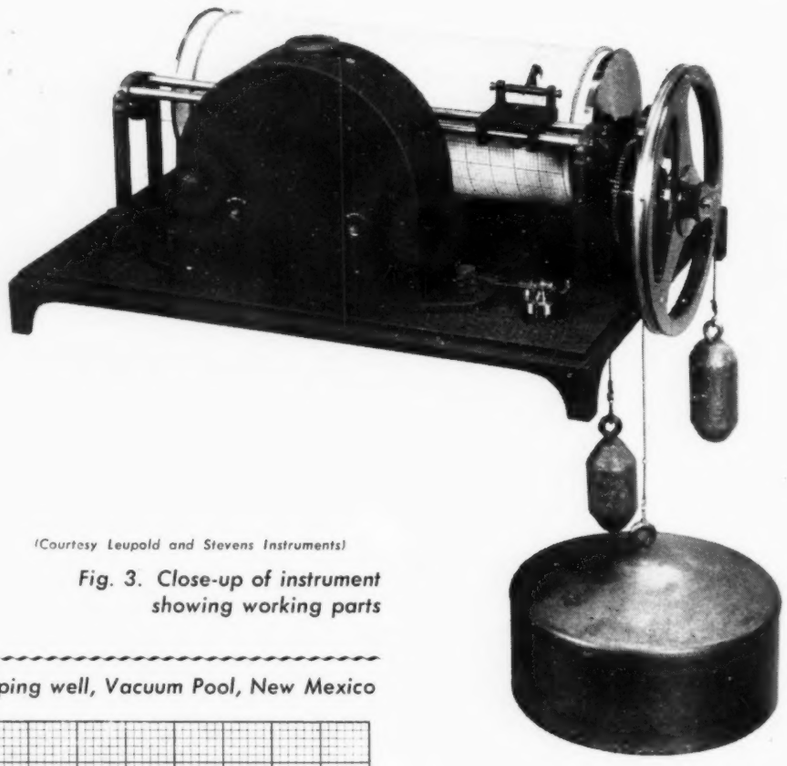
Another application of the instrument is that of recording the time a pumping well will produce before "pumping off". In making this test, the recorder is attached to the lease tank, the pump started and allowed to operate

LEONARD C. HALPENNY

was born in Winnipeg, Canada, and moved to South Texas in 1925—He graduated from the University of Texas as a petroleum engineer in 1938 and was employed by the United States Geological Survey in Austin, Texas, and Tucson, Arizona, from 1938 until September, 1941, when he entered the employ of The Ohio Oil Company—At present he is stationed at Hobbs, New Mexico.

until no more oil is being pumped. The amount of oil produced per hour will steadily decrease after a time, depending upon the individual well. The graph produced will indicate the time at which the rate of production declines below the point of profitable production. Obviously, the future pumping program for the well should be based on the number of hours per day that it is profitable to operate the pumping unit. Fig. 2 shows a graph of such a test; from this graph it was determined that the well should be pumped about 10 to 12 hours a day.

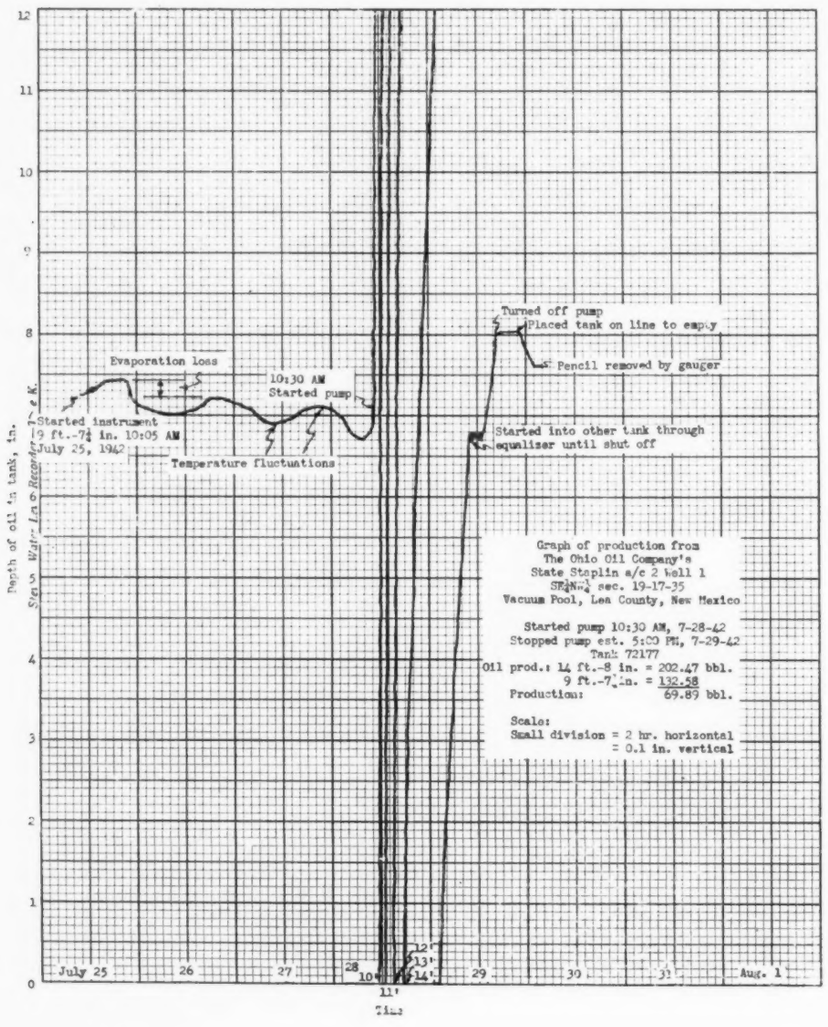
As a result of the test just mentioned, the ability of the instrument to measure the result of temperature changes and to measure daily loss by evaporation was revealed. In the graph shown in Fig. 2, the recorder operated for three days before the pump was started. The maximum range of fluctuation as a result of temperature was 0.4 in. per day, and the fluid lost by evaporation was about 0.1 in. per day. The tank used was about 15 ft. high, of 200-bbl. capacity. From these observations it was evident that the recorder could be used to determine the desirability of vapor-proofing tanks, and also to measure the effectiveness of vapor-proofing. To make a successful test on a vapor-tight tank, the hatch should be closed and the necessary wires passed through openings of small diameter in the roof of the tank.



(Courtesy Leupold and Stevens Instruments)

Fig. 3. Close-up of instrument showing working parts

Fig. 2. Graph of production from a pumping well, Vacuum Pool, New Mexico



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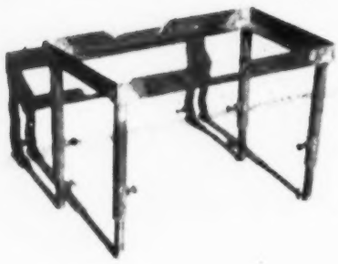

Fig. 4. Adjustable stand for fluid level recorder

Description of Instrument

The type of instrument used by the writer is one that has been used for years in the measurement of water behind dams, in irrigation ditches and canals, at river gauging stations, and to record fluctuations of water level in wells. It consists of a horizontal cylindrical drum covered with a chart and revolved by a cable attached to a float and counterbalance, and a pen or pencil moving horizontally along the drum and controlled with a clock (see Fig. 3). In gauging oil production, the float is controlled within the tank by being enclosed in a stilling well, to keep the float directly beneath the sheave attached to the drum, and to minimize false readings caused by waves and foam in the tank. The pen or pencil slides along two polished rods, and is attached with a flexible wire to the clock at one end and to a counterbalance at the other. As the clock unwinds the counterbalance pulls the pen or pencil along the guide rods, making a horizontal line on the chart on the drum. If the fluid level is rising the line produced will be diagonal, as the drum will revolve slightly. Various combinations of gears are available for both the time element and the fluid level element, so that the graph produced can be of any scale desired. The writer found that a time scale of 0.2 in. per hour and a direct fluid level scale (1 in. per in.) were satisfactory for most tests. For tests lasting a week, a time scale of 0.05 in. per hour has been found satisfactory. The circumference of the drum is 1 ft. and if the fluid level in the tank rises several feet during a test, the drum merely continues to revolve and the graph produced will be a series of parallel diagonal lines, as shown in Fig. 2.

Fig. 5. Part of stilling well, showing brackets with which to hang in tank hatch opening

An adjustable stand was developed for use on lease tanks (see Fig. 4). It is made from light bed rails for the frame, and of ¾-in. pipe and sucker rod for the telescoping legs. It is possible to adjust the legs to produce a level surface on a sloping tank roof, and also to raise or lower the frame barely to clear the open hatch. The stilling well is made from sections of 6-in. stovepipe, the top section of which has two shelf brackets attached so that it will hang vertically in the tank opening (see Fig. 5). Additional lengths of stovepipe are attached with sheet metal screws as needed to adjust the depth of the stilling well to the height of the tank being measured.

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P 094.6

Life of Belting Influenced by Tension Factor

EVIDENCE that the life of transmission belting and V-belts is greatly influenced by the tension factor, and that an increase in the tension over that recommended for the belt operation will result in failure of the belt long before it should break down is provided by data from a series of tests conducted under the supervision of George H. Stewart, belting engineer of The B. F. Goodrich Company.

Results of the tests are released by the company as another contribution to the country's rubber conservation program.

Three grades of the present war-time construction of transmission belting were used in that series of tests, which were run at 15 lb. per in. per ply, a 720 lb. total for the tension, the recommended figure, and at 18 lb. per in. per ply, a total of 864-lb. tension, on 4-in. pulleys. Belts were all 6 in. wide, 30 ft. in length, spliced in 10-ft. endless lengths. Tests were all highly accelerated.

Belt No. 1 ran for 95 hours before breakdown while under the 18-lb. tension, and increased its life to 230 hours before failure when the 15-lb. tension was used.

Belt No. 2 ran for 88 hours at the 18-lb. tension, and for 263 hours before failure at 15-lb.

Belt No. 3 ran for 15 hours under 18-lb. tension, and the service life before failure increased to 48 hours under the 15-lb. tension.

Conclusions reached, Engineer Stewart's report says, are that an increase of 3 lb. per in. per ply over the recommended tension results in the belt giving only approximately one-third of its useful service life.

Similar conclusions were drawn from tests conducted on one style of V-belts, used on a popular make washer. The accelerated test consisted of a dead load suspension with the driver sheave 2⅝ in. O.D. by ½ in. top by 36 deg. and the driven sheave of 5¼ in. O.D. by ½ in. top by 40 deg.

First three belts under tension of 125-lb. center-to-center, averaged 4½ hours of life before failure.

Second three, under 95-lb. tension centers averaged 27.4 hours, whereas the last three, under 80-lb., averaged 86 hours.

In giving these test results, The B. F. Goodrich Company points out that because of their short, highly accelerated nature, they are not an index to life in actual service, and were made only to get data on the ratio of tension to belt life. To have any direct evaluation to real service, tests should be made for much longer periods, the report discloses.

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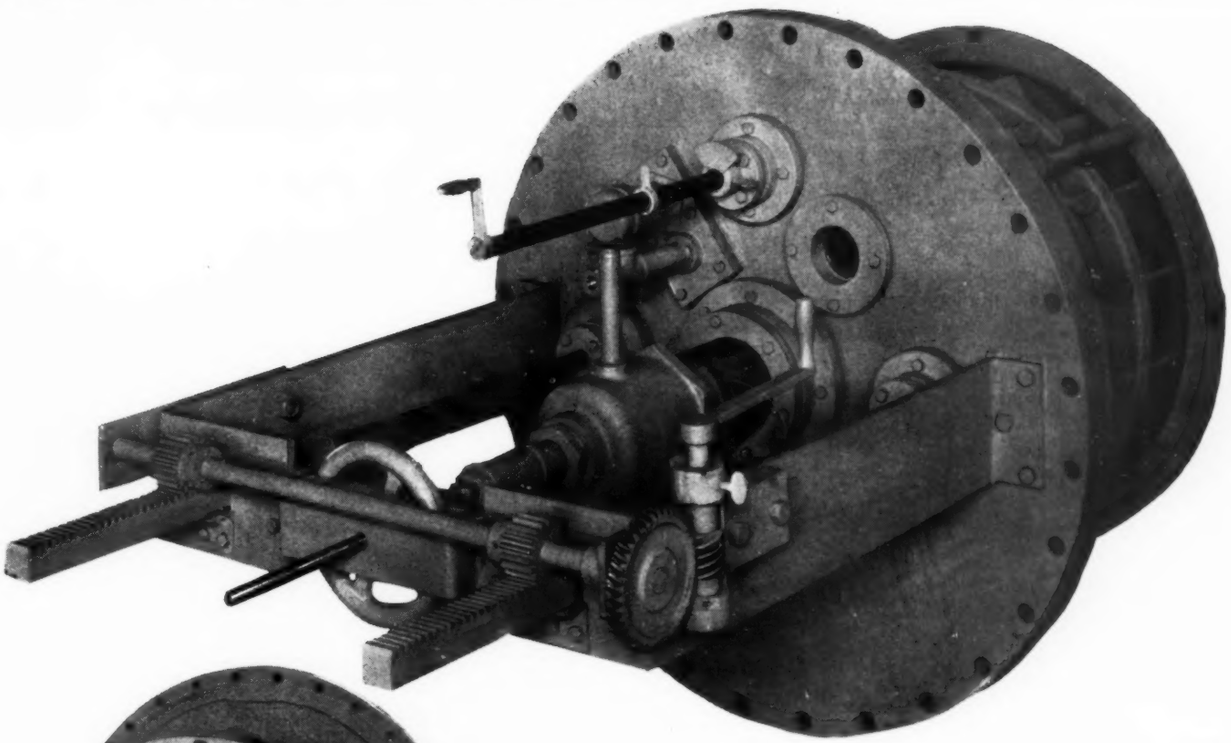

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Underground Gas Storage Project in California

PETROLEUM ENGINEER Exclusive Feature

Utilization of virtually depleted producing sand in conveniently situated oil field assures winter fuel supply for war industries

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

THE vast war industries of Southern California depend almost entirely on natural gas for fuel. Although this area enjoys a mild climate, and temperatures in most districts seldom fall to the freezing point, the variations in seasonal demands for fuel, as indicated in Fig. 1, are decidedly pronounced. It has therefore been decided to utilize the nearly depleted deep producing sand of one portion of a conveniently situated oil field as a storage reservoir to provide additional gas during the winter season and thus insure an adequate supply for the demands of war industries.

Although a mild winter might necessitate no gas requirements in excess of normal supply, the estimated peak of noncurtailable 24-hr. demand for the metropolitan Los Angeles and San Diego areas has been computed to be 606,000,000 cu. ft.[1] The normal supply of gas to these areas is 528,000,000 cu. ft. but this is based on continuous supply without interruption from any cause. This leaves a possible deficiency of 78,000,000 cu. ft. There is also an industrial load (sold on a surplus basis) of 145,000,000 cu. ft. The gas companies cannot add to their facilities to take care of the war demand because new installations that necessitate storage tanks, pipe, fittings, and considerable other equipment would require a great amount of metal and other vital war materials.

The gas being used in the Los Angeles area comes from the Los Angeles Basin, Coastal District, and San Joaquin Valley fields. The San Diego area is also supplied by the gas companies that supply gas to the Los Angeles metropolitan area and the storage project thus affects both areas. There is not now a surplus of gas from the Los Angeles Basin fields, however, so all gas to underground storage must be taken from the lines transporting gas from the San Joaquin Valley and Coastal fields.

Gas Conservation

In deciding on underground storage near Los Angeles conservation was also an important factor. Very little gas is going to waste in California (in fact, present wastage is the lowest in California's entire production history) but even some of this waste will be reduced by storing the gas in the summer months when the line from the San Joaquin Valley can carry more than the demand. Fuel oil could be used to supplement the supply in an emergency in normal times but fuel oil in California cannot be sacrificed for this purpose during the war. Heavy oil production is being stimulated to the greatest extent possible at the present time in order to obtain the maximum amount of fuel oil and this fact in itself has been an influence on the natural gas supply, as the production of light oil with which most of the casinghead gas is produced is being restricted to definite allotment.

The field being used was selected because of its location near the load center of metropolitan Los Angeles, its proximity to a natural gas trunk line, its geological structure, and the near depletion of its producing zone.

[1]Estimates of demand, storage capacities, etc. and the geological data given in this article are from the California State Railroad Commission's Special Study S-325, July 20, 1942, entitled "Playa del Rey Gas Storage Project."

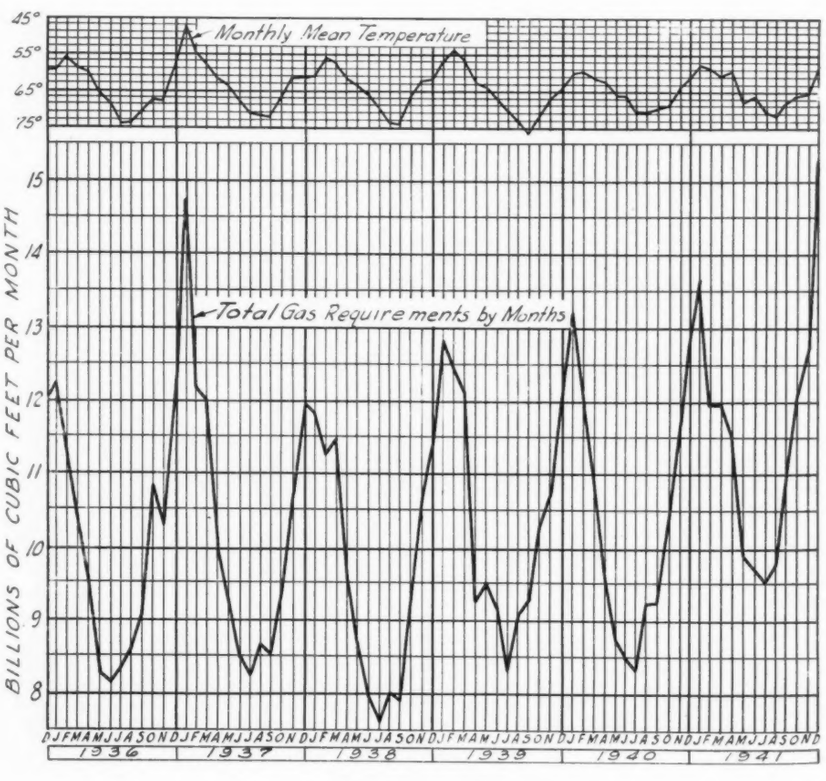

Fig. 1. Showing seasonal demand for natural gas in Southern California, south of Fresno and Paso Robles. (Data supplied by Department of Petroleum Engineering, Southern California Gas Company)

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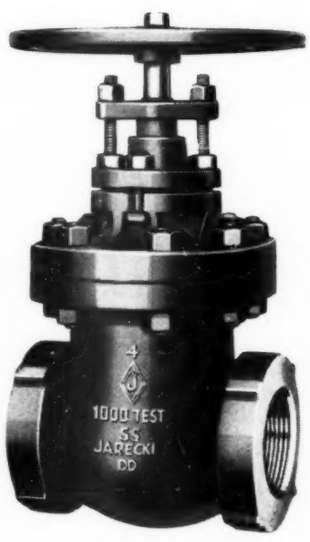

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Reservoir Sand

The proved producing area of the portion serving as a reservoir is 310 acres in extent of which approximately one-half is held by the Union Oil Company; the other half, a town-lot area, is controlled by about 200 small lease and royalty holders who are scattered over the country. There are 19 producible wells on the Union Oil Company property and 18 on the town-lot area. Approximately one-half of these are now on production.

Obviously, some unified control of the field was necessary for successful operation of a gas storage project so an appeal was made to the Federal Government to acquire the property rights. This appeal was made to the Defense Plant Corporation upon recommendation of the California State Railroad Commission, which had made a survey of the project, of the California State Department of Natural Resources, which had coöperated with the Railroad Commission, and of the OPC and WPB, which made studies of the report submitted by the Railroad Commission. Acting on this appeal, formal possession was taken by the United States Government late in September, 1942, and the first gas was injected on October 12, 1942.

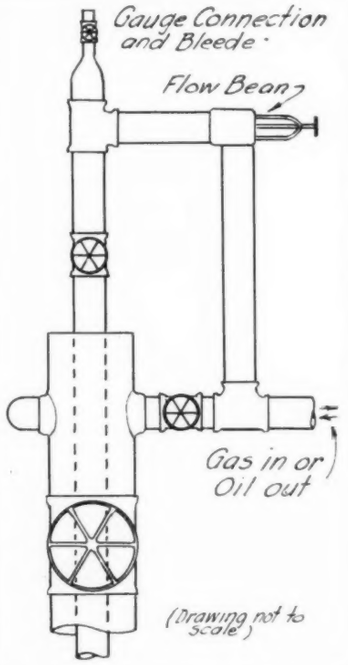

Fig. 2. Diagram of injection well-head connections. Gas can be forced downward through either the tubing or between the tubing and casing. When the well is to produce oil, production usually passes from the tubing through a bean

Maintenance and Operation

The gas is piped to the field by the Southern California Gas Company and at the present time is injected through three wells that originally produced oil. The necessary functions in addition to installation and operation of facilities for injection and withdrawal of gas by the gas company are performed by the Union Oil Company, named agent for the Defense Plant Corporation, and these functions include everything concerned with the operation and maintenance of wells. The gas company pays for use of the reservoir and makes compensation for deferment of oil production.

In estimating the net value of future oil production from the wells still producing in the field due consideration was given to the fact that such production will be disturbed by the gas storage operations and that the rate of production when spread over a period of time will be reduced.

Capacity of Reservoir

The study of this field made by the State Railroad Commission was based on drillers' logs, electric logs, core rec-

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ords, and other available subsurface data. Contour maps were made of the top of the producing zone and of the schist underlying that zone. From these the thickness of the sand above the water table was determined and an isopach map of the sand thickness for the area was constructed.

The oldest formation penetrated in the field[1] is a metamorphic rock known as the "schist." Over and against this the oil-bearing and other sedimentary rocks have been deposited. Next oldest is called the "conglomerate", which is actually a partially stratified mixture of sand and conglomerate in varying proportions. This is the chief oil-bearing formation in the field. Above this is the Nodular Shale, which, although containing some gas and oil as disclosed during the drilling of the wells, acts as a cap rock.

There appears to be no actively encroaching edge water in the field. Depletion has been due almost entirely to gas expansion and it is believed that the reservoir sands originally containing oil and gas are still free from encroaching water. The original reservoir pressure at an average mid-point of the reservoir was 2750 lb. per sq. in. and the temperature 235°F. The bottom-hole pressures at the beginning of the storage project were as low as 30 lb. per sq. in. in some places.

By laboratory tests the porosity of the sand was found to be 26 percent and the permeability 500 millidarcies. The interstitial water was estimated as 25 percent of the pore space. Using these factors and taking into consideration reservoir characteristics, correction being made for temperature but not for possible reservoir shrinkage due to encroaching edge water, it was calculated that a gas storage of 2,000,000,000 cu. ft. would be provided by the 20,428 acre-ft. of sand estimated as effective for storage.

The actual volume available for storage is probably half again as much, but the 2,000,000,000 cu. ft. is believed to represent a volume of gas that may be stored and withdrawn with pressure conditions under which it is practicable to operate the project.

Equipment Required

As with all projects consummated during war time the equipment and materials necessary for the utilization of the field as underground storage for gas had to be readily available. Much of this was second-hand and what new material was used was in stock. The main trunk line from which the gas is taken for storage is approximately 3.5 miles from the field. This line has a diameter of 26 in. and the line from it to the compressor site required 18,000 ft. of 12¾-in. pipe. A portion of this line was constructed of salvaged pipe that was reconditioned at one of the gas company's plants. Additional pipe necessary for distribution and collection and for injection service consisted of 2700 ft. of 8⅝ in.; 2500 ft. of 4½ in., and 2500 ft. of 3½ in. Most of this was salvaged pipe also, but as all lines will eventually have to carry pressures up to 1000 lb. per sq. in. or more, the pipe had to be in such condition that it could be relied on to perform the service safely and without undue maintenance.

At the present time gas is being injected without compression at line pressures between 125 and 165 lb. per sq. in. A considerable volume of gas can thus be put into the sand before the line pressure must be increased. A compression plant is being constructed, however, and eight 200-hp. main compressors and one 160-hp. auxiliary compressor will be installed.

These compressors have been in service in the San Joaquin Valley but, being idle at the present time, will be moved to the storage field. With the cylinders with which they are now equipped they will be able to boost the gas from the line pressure of approximately 150 lb. per sq. in. to 500 lb. per sq. in. It is estimated, however, that for each 384,000,000 cu. ft. of gas stored a pressure

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(Left, above) Pacific "Oil States" Insert Liner Pump, and (right) Tubing Type Liner Pump.

increase of approximately 100 lb. per sq. in. will be necessary. In order to obtain 2,000,000,000 cu. ft. of usable storage with 1,000,000,000 cu. ft. back-log, an injection pressure of at least 1000 lb. per sq. in. will be required. Two-stage compression will therefore be necessary, the first stage compressing the gas from line pressure to 450 lb. per sq. in. and the second stage capable of boosting to 1500 lb. per sq. in. Half the units will be equipped with high-pressure cylinders.

Hydrogen Sulphide Content

The original gas in the field contained hydrogen sulphide in varying amount up to 7 grains or more per 100 cu. ft. so some contamination of the gas is expected when it is placed in the sand for storage. Although this contamination will probably decrease as the reservoir is used, purification equipment will be installed before withdrawals are made.

More wells will be equipped as injection wells later, as only three are on this service at the present time. Material for this work, however, is on hand. Gas injection began at the rate of approximately 4,000,000 cu. ft. per day. The volume of gas injected during the coming weeks will, however, be governed by the surplus available, for it will be limited by the increase in demand in cold weather. The compressor plant will be ready for operation by next spring when more surplus gas for storage will be available after the winter heating season is over.

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Help to "Top That 10 Percent by New Year's"

STRONG support for the War Savings Program is coming from business and industry. Not only are the managements of a wide variety of private firms coöperating with labor to introduce payroll savings plans for war bond buying, but many of these firms are qualifying as issuing agents for the Series E Bonds. The drive under way to "Top That 10 Percent By New Year's", and raise the number of payroll savings participants to 30,000,000 workers, will create an even greater need for employer issuing agents.

Nearly 7000 business and industrial companies have already become issuing agents for Series E Bonds, many of them for the purpose of issuing bonds to their employees through payroll savings plans. All kinds of enterprises are represented in the list: retail stores, plants, factories, and insurance companies. Included also are some American branches of foreign companies, although this latter group, of course, can issue and sell bonds only to residents of the United States.

The total number of non-governmental issuing agents for Series E Bonds is now nearly 29,000. In addition to the list of nearly 7000 industrial and commercial companies mentioned above, this aggregate includes about 15,000 banks; more than 3000 building and loan associations, and nearly 3000 credit unions.

The shouldering of a part of the work by private firms has been an important factor in the spread of payroll savings plans. The issuing of large numbers of small denomination bonds entails an enormous amount of work that at times has threatened to swamp the facilities of banks and other agents, and to slow up bond deliveries to a corresponding degree. The increase in the number of employer issuing agents facilitates issues and speeds up deliveries.

In the case of a bond purchased through a payroll savings plan, moreover, the fact that the employing organization issues the bond assures to the investor the earliest possible dating of the bond, with no lapse of time, after the price of the bond has been accumulated, before the funds begin to earn interest. There need be no waiting until the employee can get out to a bank or a post office to make his last payment or purchase his bond. As bonds are dated as of the first day of the month in which they are bought, if the pay day that makes possible the last payment on a bond should fall on the last day of the month, the delay of one day in making that payment would cost the employee an entire month's interest.

Organizations operating payroll allotment plans for employee purchases of war bonds should apply to the Federal Reserve banks for designation as issuing agents for Series E Bonds. An organization that would, in all probability, issue E Bonds to its employees in a number sufficient to warrant its becoming an agent can obtain an application-agreement form for the purpose from the Federal Reserve bank of its district. The form, which is brief and simple, must be signed by the president or vice-president of the firm.

It is not required that business and industrial organizations deposit collateral to qualify as issuing agents for Series E Bonds. A very simple arrangement has been established whereby employer firms operating payroll savings plans pay in advance for all bonds that they require for issuance to their employees. This procedure permits prompt receipt of funds by the Treasury and works no hardship on the firm, as the payments are not made from the working capital of the firm, but from amounts accumulated through payroll deductions and held in trust for employee bond purchases.

Wherever it is practicable firms that are issuing agents deliver bonds directly into the hands of employees who have purchased them. In some cases, however, particularly in industrial plants and shops, working conditions make this manner of delivery impracticable, and bonds are sent to their owners by registered mail. Such mailing costs are refunded to agents through Federal Reserve banks, and as soon as arrangements can be made it is planned to simplify the mailing procedure.

From 21 to 22 million American workers are already participating in payroll savings plans to the extent of 7.6 percent of total earnings. This percentage, of course, is based upon averages. Many workers have already pledged 10 percent of their pay for war bonds; others have exceeded that figure. As of October 21, 1942, there were 25,835 companies with 3,037,167 employees, all of whom had authorized deductions of at least 10 percent of their pay for the purchase of war bonds.

On November 16 the United States Treasury Department with the help of leaders of management and labor, launched a campaign to increase the number of participants in payroll savings plans to 30,000,000 and the percentage of earnings pledged to better than 10 percent by January 1, 1943.

—— ☆ ☆ ☆ ——

For many years KEROTEST has been an outstanding leader in designing and building valves for the oil industry—today Kerotest's capacity is being devoted 100% to our war effort. Specially designed valves, as well as numerous other vitally important items required in our national war effort, are today being delivered "In time" and in many cases "ahead of schedule," thanks to the aggressiveness and wholehearted cooperation of every man in the Kerotest organization.

We are doing the job we are best fitted to do and are gratified to have our efforts recognized by the U. S. Maritime Commission with their recent "M" Production Awards to the Kerotest employees.

KEROTEST

KEROTEST MANUFACTURING CO.
PITTSBURGH, PENNSYLVANIA

LAUGH WITH BARNEY

A negro boxer was to fight a deadly champ. When the colored boy reached the ring, it was noticed he hung back.

"It's all right, Sam," soothed the manager. "Just say to yourself, 'I'm going to beat him' and you'll win."

"Sorry, Boss; dat won't work. I knows what a big liah I is."

* * *

Two pigeons, residents of New York's Public Library's ledges, were sitting discussing this and that one sunny day, when a foreign pigeon alighted and minced toward them.

"Get a load of that," exclaimed one of the natives to the other, "that pigeon is walking people-toed!"

* * *

A man who had never seen grapefruit or Florida took a trip to Florida and saw a grapefruit tree.

"Good gosh," he exclaimed, "will you look at them oranges! Wouldn't take many of them to make a dozen!"

* * *

Mushy, What?

Blessings on thee, pretty miss;
Quaker maid I long to kiss.
With thy merry wanton quips,
And thy quirking lipstick lips.
All that sort of thing connotes
That thee knows thy Quaker Oats.

* * *

Traveler: What's the use of having a time-table if your trains don't run on it?

Porter: Now you're all excited. How could you tell they was runnin' late if you didn't have a time-table?

* * *

"You know, I think that recruit used to be a bookkeeper."

"Why?"

"Well, every time he stands at ease he tries to put his rifle behind his ear."

* * *

"My poor brother has just reached the end of his rope."

"Where are you going—to cheer him up?"

"No, to cut him down."

* * *

"What's the big idea, wearing my raincoat?"

"It's raining. You wouldn't want your suit to get wet, would you?"

* * *

Some people grow old gracefully, others keep disgracefully young.

Judge: You are charged with assault and battery.

Prisoner: At last a place where my credit is good.

* * *

"Cheer up, old man! Why don't you drown your sorrow?"

"She's stronger than I am and, besides, it would be murder."

* * *

We don't know what electricity really is, and you don't know. That's why the electric company sends you a bill for a number of "watts?"

* * *

It is wonderful how people's tastes change with the years. When they are small, girls love dolls and little boys have a yen for soldiers. When they get older the girls are crazy about soldiers and boys fall in love with dolls.

* * *

Little Boy: Mother! Mother! give me a nickel for a poor man who is out in front crying.

Mother: Surely. Poor man, what is he crying about?

Little Boy: He's crying: "Fresh peanuts, 5 cents a bag!"

* * *

"Are you a contributor to the Atlantic Monthly?"

"Not exactly. This is my first trip."

* * *

It seems that one chap rushed up to another more or less excitedly and cried out, "Binks, the lawyer is dead! They found him lying on his back!"

"Binks?" queried the other calmly. "It can't be the same man. If it were Binks he'd be lying on either one side or the other."

* * *

She: I'm so glad you like it, dear. Mother says chicken salad and strawberry tarts are the only things I make correctly.

He: Which is this, darling?

* * *

Wife: Did you see those men staring at that girl as she boarded that train?

Husband: What men?

* * *

What's this we hear about all the draftees sitting around and knitting sweaters for Lana Turner?

* * *

"Listen, mugg, do you and your wife fight when you're alone?"

"I guess not. The whole town knows about it next morning."

Coming Out of the Hole

By BILLY MCGRAW
(Poet Laureate of The Los Angeles Nomads)

The clank of the table is stilled again,
And the mud pump's bark is o'er,
And each roughneck returned to life,
Is back on the derrick floor,
With a hitch to his belt, and a final drag,
On a fag ere it's flicked away,
And a grimy grin ere he settles in,
To the final work of the day.

We're coming out of the hole, my lads,
There's plenty of work ahead,
So man the cat head, Blondy boy,
And the fourble board for Red,
We'll round trip in, in record time,
With the help of every soul,
So give her hell, and do it well,
For we're coming out of the hole.

A sight to see that's good for the soul,
Is the work of a rotary crew,
As they break and spin and rack the pipe,
And never a bobbled cur,
Mid the slime and slush of a dripping pipe,
Their grip is sure and strong,
As oft in the din of the roaring twin,
They break out with a song.

We're coming out of the hole, my lads,
The bit's badly scored,
And Blondy's on the cat head, while
Old Red's on the fourble board,
We'll catch the tongs upon the fly,
So let the engine roll,
And the whole world tell, we'll give her hell
For we're coming out of the hole.

—*Flying Carpet.*

* * *

"Mister, that sure is a sure-footed horse you sold me."

"How did you find out so soon?"

"He kicked me in the same place three times."

* * *

"Old Doc Curem has given his young wife two days to live."

"Is that so?"

"Yeah, he went out of town for a couple of days."

* * *

"So you got a break in Hollywood?"

"Yes, in every promise."

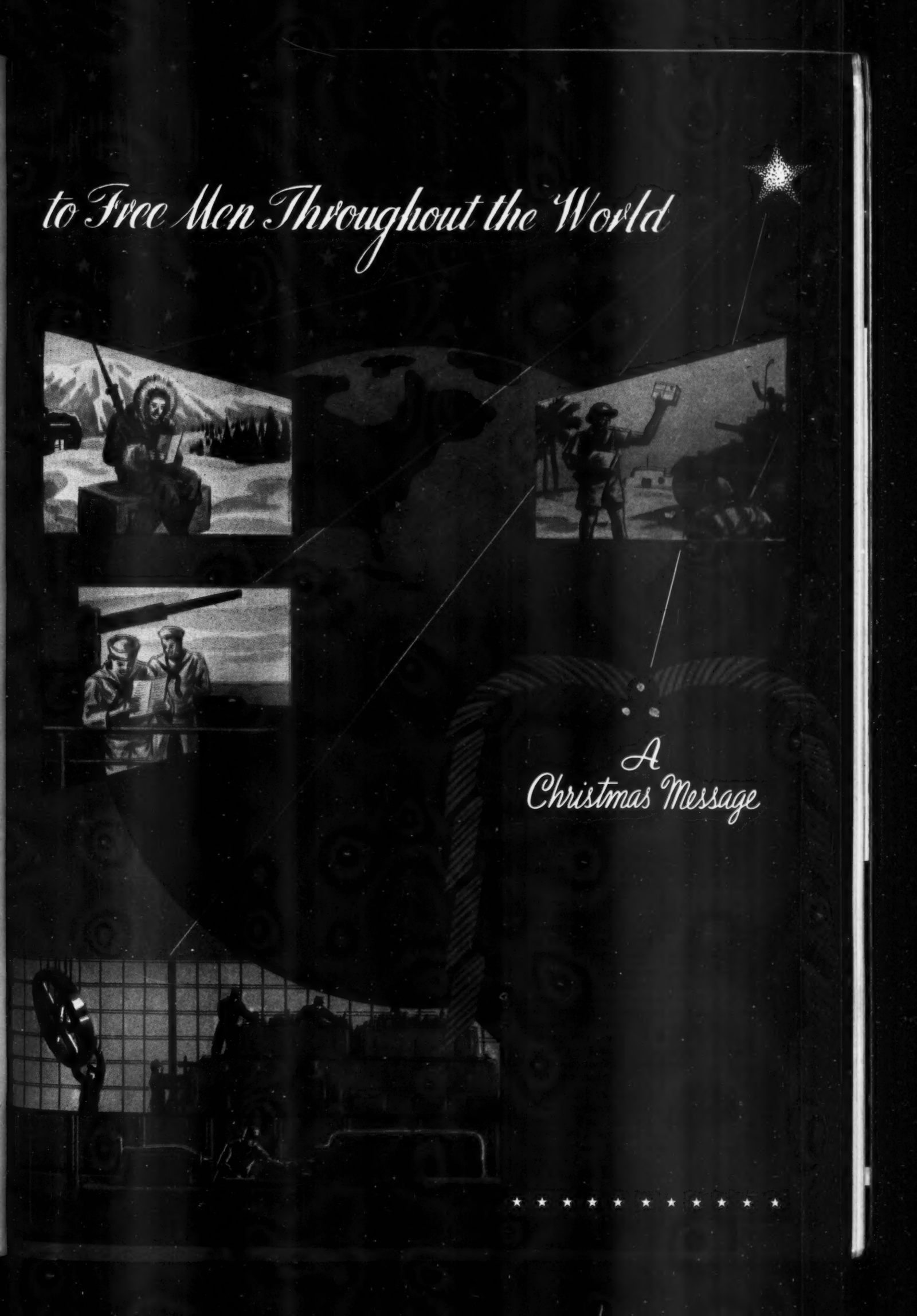
* * *

He took her gently in his arms
And pressed her to his breast.
The lovely color left her face
And lodged on his full dress.

* * *

"Do you believe in love at first sight?"

"Well, that all depends on who's in sight."


to Free Men Throughout the World
A
Christmas Message

Running Tour

WITH MEN IN THE INDUSTRY

R. H. McPEAKE, sales manager of the Export Division, Oil Well Supply Company, 30 Rockefeller Plaza, New York, New York, has been commissioned a lieutenant in the USNR and left New York at the end of October to assume his new duties. During Mc-

R. H. McPEAKE

Peake's tenure with the U. S. Naval forces, the manager of the Export Division, M. E. NICKLIN, will be assisted by M. E. KEENAN who was transferred from a Canadian District of the company early this year. McPeake is a graduate of the U. S. Naval Academy, Class of 1930, and has been connected with the oil industry since his graduation. He has lived and traveled extensively in South America during his association with the Export Division of the Oil Well Supply Company.

J. H. GRAHAM is now a gasoline and natural gas analyst for District 3 of O.P.C., making his headquarters at Houston, Texas. He formerly was with Larkin and Graham, Tulsa, Oklahoma.

J. B. MORRIS with Magnolia Petroleum Company at Tyler, Texas, has been transferred to Oklahoma City, Oklahoma.

B. A. RAY has resigned from the geological staff of the Tide Water Associated Oil Company to take charge of the district office recently established at Midland, Texas, by the Lario Oil and Gas Company.

MARSHALL R. JOY, assistant district superintendent in the Michigan-Illinois division of Cities Service Oil Company, was transferred December 1 to New York City. C. C. EVANS has been transferred from Seminole, Oklahoma, to take over Joy's vacated post in Michigan and Illinois.

E. A. MORROW, production superintendent for C. L. Maguire, Inc., has been elected chairman of the Michigan Chapter of the American Petroleum Institute. WALKER FRANKS, Gordon Oil Company, is first vice-chairman; GLEN SLEIGHT, Sun Oil Company, second vice-chairman, and W. E. SCHOENECK, Ohio Oil Company, secretary-treasurer.

G. S. TAITT, formerly chief exploitation engineer for United British Oilfields of Trinidad, is now connected with the Exploration Department of Shell Oil Company, Inc., and is making his headquarters at Houston, Texas.

D. O. BARRETT of the Gulf Oil Corporation recently talked before the Engineers Club of Tulsa, Oklahoma, on the subject "Engineering Bypasses War-Shortages".

J. D. McCAMEY, Tulsa, Oklahoma, safety engineer with the Carter Oil Company, has been commissioned a captain in the United States Army.

R. B. CAMPBELL, consulting geologist of Tampa, has been elected president of the Florida Academy of Science to serve for 1942-43.

JOHN P. SMOOTS, who has been in charge of production for the Standard Oil Company of Ohio, has been made manager of the exploration and geological department. EARL D. WALLACE has been named manager of the land and production department. The latter resigned from the Petroleum Exploration Company to take over his new duties.

A. W. HUBBELL has resigned as manager of the Gasoline Pipe Line Department, Phillips Petroleum Company, Bartlesville, Oklahoma, to devote his entire time to management of his personal properties. He is succeeded at Phillips by J. W. BOYD.

PARK J. JONES, The Texas Company, has been transferred from the petroleum engineering department in Fort Worth, Texas, to Houston, Texas.

ROBERT R. THOMPSON has resigned as chief geologist for Danciger Oil and Refineries, Inc., to become chief geologist for Snowden and McSweeney Company of Fort Worth, Texas.

HERMAN STABLER, chief of the Conservation Branch of the United States Geological Survey, died November 24 in Washington, D. C. He had been with the Survey almost 40 years and had been chief of the Conservation Branch since its organization in 1925.

T. G. FISHER, geologist at Odessa, Texas, for Cities Service Oil Company, has been commissioned a lieutenant (j. g.) in the Naval Reserve and has reported to Tucson, Arizona.

LAURENCE BRUNDALL, geologist with Shell Oil Company, Inc., Tyler, Texas, has been commissioned an ensign in the aviation branch of the Naval Reserve.

BYRON R. GOSSETT, assistant district superintendent in the Lovell Lake district, Texas, for Humble Oil and Refining Company, now occupies a similar position in the Raccoon Bend district.

GEORGE PASQUELLA, engineer and geologist, has been retained by the Interstate Oil Compact Commission to aid in making a survey of the stripper well situation in the United States.

J. C. WALKER, Cities Service Oil Company, Bartlesville, Oklahoma, and B. W. LOGUE, chief chemist, The Texas Company, Tulsa, Oklahoma, addressed the Oklahoma Minerals Industries Conference at Oklahoma City, December 10, on the subjects "Chemical Trends in the Petroleum Industry", and "Oklahoma Oil-Field Brines and Their Utilization".

F. J. BURROUGHS, JR., production foreman at Kilgore, Texas, for Shell Oil Company, Inc., is now an aviation cadet stationed at Nashville, Tennessee.

H. B. WEAVER has returned to his duties as production foreman for the Mene Grande Oil Company in Eastern Venezuela after spending two months in the United States.

J. N. PHELAN, JR., formerly an oil operator at Houston, Texas, has been commissioned a flight officer in the R. A. F. and transferred from the Terrell, Texas, training base to foreign duty.

It Takes a Beach-Head to Start an Invasion

This welded steel amphibian tractor is the Marines' answer to tough "competition" that beat us to the offensive, then dug in.

ALTER EGO: Those few Marines may not win the war by themselves, but they will establish a beach-head and that's a mighty vital prelude to dislodging Axis "competition".

Yes, war is like that. Business now is somewhat like that. Business after the war will be just like that!

ALTER EGO: Right. To win the Battle for Business after this war we're going to have to get on the offensive with welded steel products.

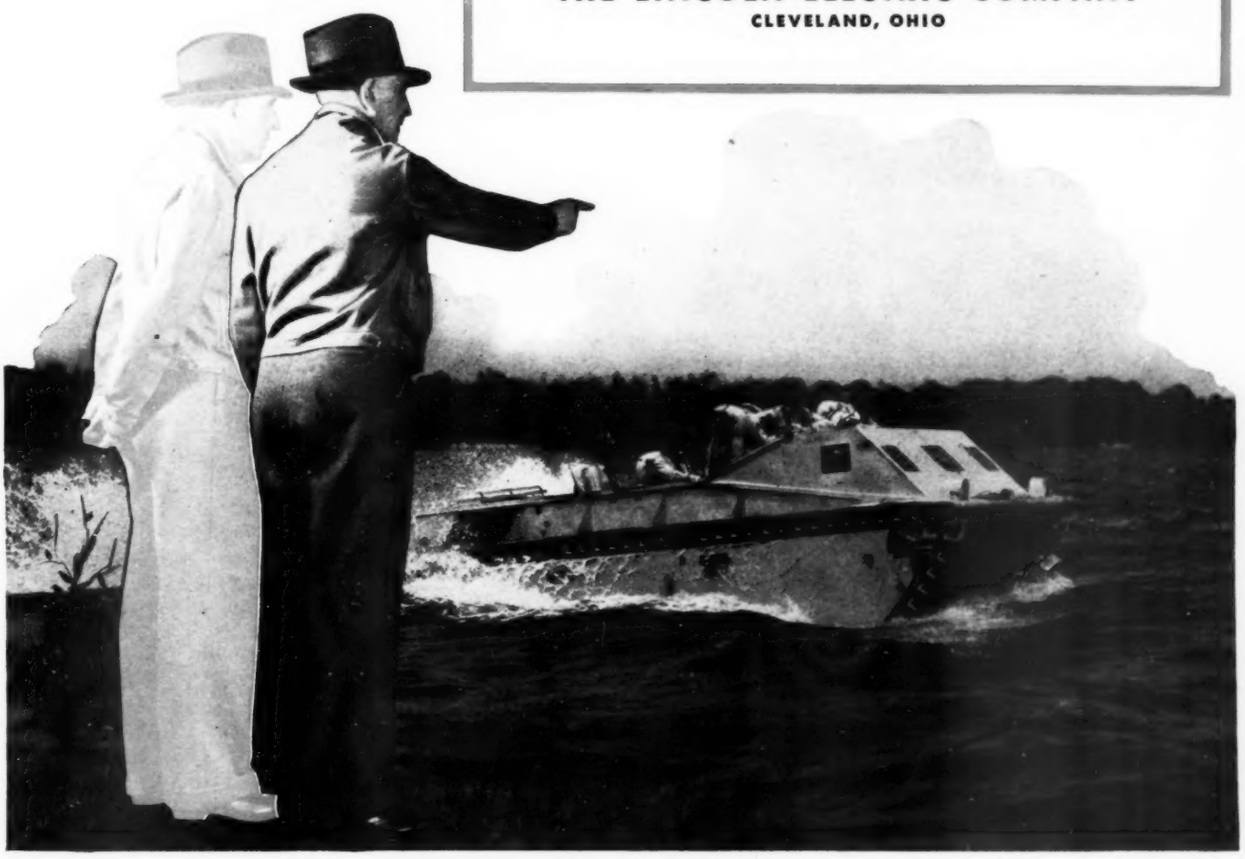
Right. But first we must establish our beach-heads of welding knowledge. Let's start this prelude to invasion of the post-war market NOW.

Ask your inner self if a "beach-head" of welding knowledge shouldn't precede post-war market invasion.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

then I said to myself—

MARINES and WELDING
—the situation will be well in hand



R. U. FITTING, engineer for Shell Oil Company, Inc., at Midland, Texas, has been elected secretary-treasurer of the North Basin Pools Engineering Committee, which handles engineering and proration problems for a group of West Texas fields. He succeeds ALDEN S. DONNELLY, Honolulu Oil Corporation. R. S. DEWEY, Midland, petroleum engineer for Humble Oil and Refining Company, has been named to the general committee, taking the place of Robert S. Christi, Amerada Petroleum Corporation, now on duty as an officer in the Coast Artillery.

C. L. BARTON, petroleum engineer with the California Oil and Gas Division, has been commissioned a captain in the Chemical Warfare Branch of the U. S. Army.

DR. CHARLES D. LOWRY, JR., of Universal Oil Products Company, discussed "New Developments in Petroleum Technology of Interest to Metallurgists and Metallurgical Engineers", recently before a joint meeting of the American Society of Metals and the American Society of Metallurgical Engineers, held in Timken High School, Canton, Ohio.

RUSSEL L. WHITNEY has been appointed sales manager of the company's Transformer Division in Sharon, Pennsylvania, according to an announcement by H. V. PUTMAN, Westinghouse vice-president and manager of the Transformer Division, Westinghouse Electric and Manufacturing Company. A. C. FARMER, formerly assistant sales manager, has been named assistant to the vice-president, and A. P. BENDER, former sales manager, has been made assistant sales manager "to afford the best possible opportunity for his complete recovery" from an extended illness.

EARL B. BUSENBERG, chief chemist of the Philadelphia Rubber Works Company, reclaim division of The B. F. Goodrich Company, has been loaned to the government to serve on the staff of technical consultants assisting William M. Jeffers, U. S. rubber director, the company announces. Busenberg will devote himself to the technical phases of reclaim rubber, a subject on which he is recognized as an authority throughout the rubber industry. Joining the Philadelphia Rubber Works Company in its general laboratories in 1922 after studying chemistry at the University of Akron, Busenberg was promoted to chief chemist in 1929. He is a member of the Akron section of the American Chemical Society.

WADE MURPHY, for the last ten years assistant to ARNOLD MICHAELSON, vice-president of the Minneapolis-Honeywell Regulator Company in charge of the eastern zone, with headquarters in New York City, is now special assistant to THOMAS MCDONALD, vice-president of the new Minneapolis-Honeywell electronics plant at Chicago.

LESTER M. COLE, district manager for the Warner and Swasey Company at Houston, Texas, has been elected a director of the American Society of Tool Engineers from Region Number 17 for a two-year term. Cole joined Warner and Swasey in 1925 as a tool de-

LESTER M. COLE

signer and estimator. He has been manager of the company's Houston office since 1928. A.S.T.E. Region Number 17 comprises Houston Chapter No. 29, North Texas Chapter No. 51, and Wichita, Kansas, Chapter No. 52. Cole is past chairman of A.S.T.E. Houston Chapter.

DR. CHARLES ALLEN THOMAS, Dayton, Ohio, and OZBORNE BEZANSON, Woburn, Massachusetts, have been elected to the board of directors of Monsanto Chemical Company, St. Louis, Missouri. Dr. Thomas is director of the Central Research Department of the company and Bezanson is vice-president and general manager of Monsanto's Texas Division. Election of the men adds to the Monsanto board of directors two men who worked their ways through high school and technical schools and who have come up through the ranks of industry to their present administrative positions.

WALTER E. HELLER, president of Walter E. Heller and Company, commercial financing and factoring firm of Chicago and New York, has been appointed chief of the Materials Program Branch of the Program Coördination Division of WPB.

DR. D. P. MORGAN of New York City has been appointed director of the Chemicals Division of the War Production Board, it is announced by ERNEST KANZLER, Director General for Operations. He will release DR. REID, the former director, for his new appointment as director for the Commodities Bureau. Before going to Washington in June, 1940, as group executive of the Chemicals Section, Materials Division, Advisory Commission to the Council for National Defense, Dr. Morgan was chemical consultant for Scudder, Stevens and Clark of New York City. J. W. REYNOLDS, Easton, Pennsylvania, who has served as assistant branch chief, has been appointed deputy director of the Chemicals Division. At the same time Dr. Reid has announced the following appointments: W. FLETCHER TWOMBLY, Reading, Massachusetts, as chief of the Aromatics and Intermediates Section. He formerly was analyst for the section. HUGH HUGHES, Bloomfield, New Jersey, as assistant to the director of the Commodities Bureau. He was formerly chief of the Aromatics and Intermediates Section.

JOE KAYSER, foreman of the boiler shop of the Standard Oil Company of Ohio refinery at Lima, has retired after serving 30 years with the company.

ED BORREGO, field superintendent, Standard Oil Company of Venezuela, Quiriquire field, is spending his vacation in Oklahoma.

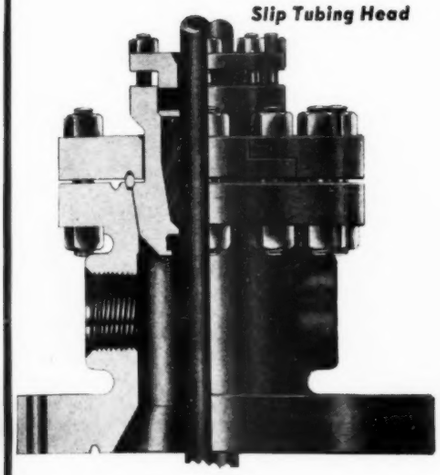
FRANK R. CREEDON has been appointed assistant deputy rubber administrator in charge of new plant construction, it is announced by Rubber Director William M. Jeffers. Creedon at present is chief construction engineer in the Office of Chief of Engineers, Corps of Engineers, U. S. Army, in charge of construction of munitions manufacturing plants.

J. D. HUNTER, West Texas operator of Midland, Texas, has been commissioned a first lieutenant in the U. S. Army Engineer Corps.

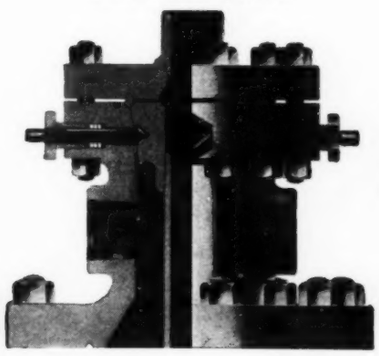
R. W. ERWIN, Salt Water Control Corporation, Kilgore, Texas, recently was elected president of the East Texas Chapter of the American Institute of Mining and Metallurgical Engineers. D. W. AKINS, JR., Ohio Oil Company, and J. S. FULLER, Oil Well Supply Company, Dallas, Texas, were elected vice-chairmen, and R. M. HESS, Shell Oil Company, Inc., Kilgore, secretary-treasurer. New directors are A. S. RHEA, Sun Oil Company, Tyler, Texas; W. E. WINN, Sun Oil Company, Dallas, and R. O. GARRETT, Arkansas Fuel Oil Company, Shreveport, Louisiana.

HEADQUARTERS FOR *Safer* WELL HEADS

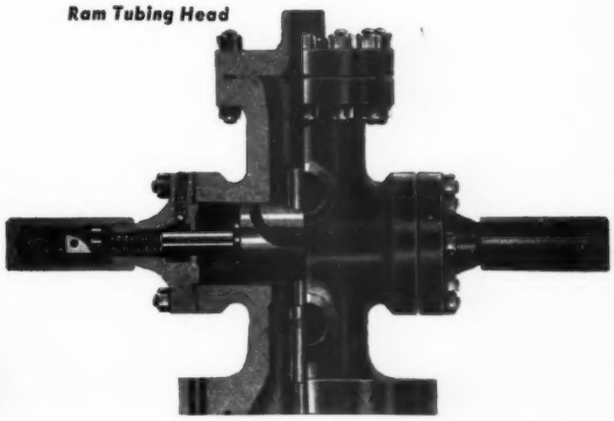
Slip Tubing Head



Mandrel Tubing Head

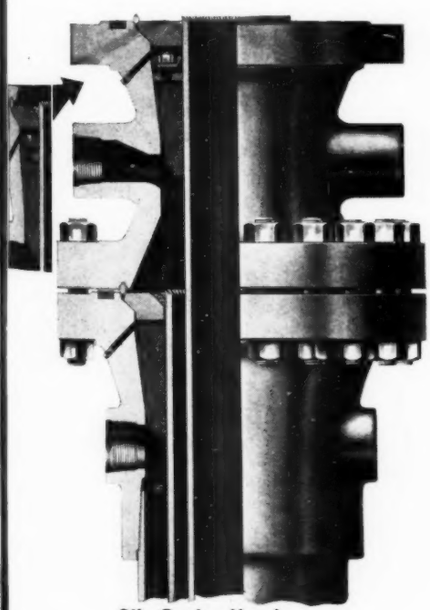


Ram Tubing Head



Rector Well Equipment Company's more than 12 years of designing, developing and manufacturing surface control equipment exclusively has resulted in a *safer casing and tubing head* to match your drilling, completion and production problem . . . whatever it may be. The reputation of RECTORHEADS is backed by thousands of safe, dependable, leak-proof well hook-ups in service around the world.

Three distinct types of Rector Casing Heads and Rector Tubing Heads pictured here are a few of the many approved RECTORHEAD designs. Full details covering these and other RECTORHEAD designs are in your Composite Catalog, your Drilling Equipment Directory, or your Rector Catalog. Many of these designs are still available from supply store and warehouse stocks in all sizes and pressures.



Slip Casing Head

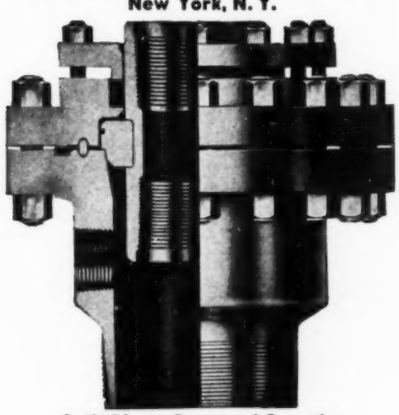
RECTORHEAD

SUCCESSOR TO THE BRADENHEAD

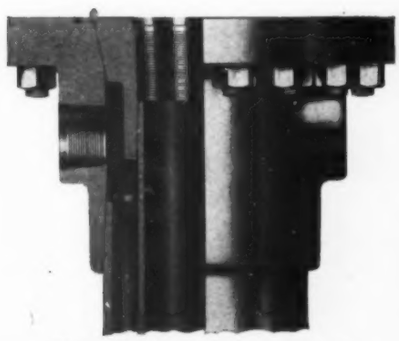
RECTOR WELL EQUIPMENT CO., INC.
Fort Worth, Texas

Representatives in All Active Areas

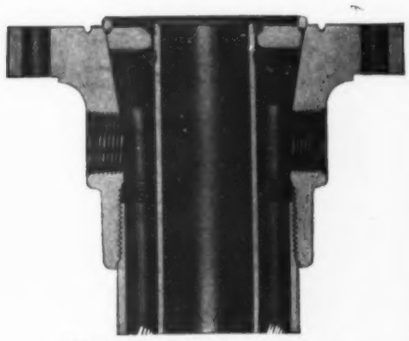
Export Office:
Lucey Export Corp., Woolworth Bldg., New York, N. Y.



Split Ring—Recessed Coupling Casing Head



Threaded Mandrel Casing Head



Welded Mandrel Casing Head

MACHINERY and EQUIPMENT

G. E. Safety Clothing

TO MEET the needs of the many women welders now employed and being trained, General Electric Company, Schenectady, New York, has announced a complete line of safety clothing designed especially for women welding operators. Safety, durability, and smart styling are combined in the new line, which is based on the results of an extensive industrial survey of safety requirements for women welders.

Featured in the line are leather sleeves, aprons, jackets, leather gloves, and a special women's head and hair covering. Designed by Sally Victor, one of the country's leading milliners, this head covering protects the hair from sparks and slag and can be used with any of the modern welding helmets.

All items in the line are of high-quality material, comfortable, and light in weight — yet they provide full protection for all parts of the body. The new line supplements G. E.'s complete line of apparel for men welders.

A new bulletin, GEA-3295, gives complete details and specifications on G. E.'s new line of safety clothing for women.

Mono-Ambulance

A NEW ambulance, which is so small and light that it can go practically anywhere, has been introduced by the B. F. McDonald Company, West Coast manufacturer and distributor of safety appliances. Known as the McDonald Mono-Ambulance, the vehicle is powered by a "scooter" type Motor Glide, and comprises a covered stretcher compartment 6 ft., 8 in. long, by 26 in. wide. The unit can carry three persons: the patient, who rests comfortably on a spring-suspended stretcher over knee-action wheels; the driver, and an attendant who ride back-to-back on the motor unit.

The ambulance unit has zippered windows at each end, permitting either the driver or attendant to watch and work with the victim while in transit. A standard first aid kit is contained in a zipper compartment at the rear. With a full load the ambulance is capable of a speed of 30 miles per hour, and is said to be extremely simple to operate. Fuel consumption is said to be very low—with 90 miles per gal. of gas one of the vehicle's chief advantages in these days of gas rationing.

Because of its compactness the McDonald Mono-Ambulance is suggested for field use and in large plants where cramped areaways, narrow aisles, rough terrain, etc., make impractical the use of full-sized ambulance equipment.

The Mono-Ambulance is also suggested for uses other than mercy assignments, as its economy of operation and large compartment make it an efficient luggage carrier and delivery car. A number of these units are already seeing service with the U. S. armed forces, and in war industries.

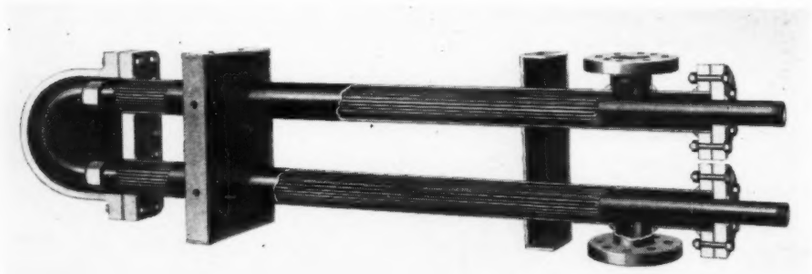
Specifications include reinforced steel "X" frame, waterproof ambulance cover, extra reinforcing in coupling and motor unit, automatic transmission and clutch. The McDonald Mono-Ambulance is 55 in. in overall width, 39 in. high, and weighs 420 lb.

Additional information may be obtained by writing B. F. McDonald Company, 1248 South Hope Street, Los Angeles, California.

Brown Fintube Heat Exchangers

THE Brown Fintube Company, Elyria, Ohio, has announced that it will build and sell complete ready-to-use heat exchangers for the duration, as a service to buyers who are unable, due to the rush of war work, to get needed equipment from their usual sources of supply.

According to a company spokesman, Brown Fintube Heat Exchangers will be built in all standard types—including the twin section unit pictured here—and in any capacity desired to meet practically any heating and cooling requirement. Brown Fintubes, with their exclusive welded construction that provides an integral bond of metal between the fin and the central member, said to result in high thermal efficiency and trouble-free operation, will be employed as the heat transfer tube in all cases.



All heat transfer calculations will be made by engineers newly employed for this particular purpose, who have had long, specialized, and successful experience in this work. More complete details may be obtained by writing The Brown Fintube Company, Heat Exchanger Division, Elyria, Ohio.

Selectograf Simplifies Quill Bearing Choice

DATA on bearing sizes, load capacities, shaft diameters, and housing bores for the Bantam Quill Bearing are given in convenient form in a new handy Selectograf.

One side of the Selectograf gives inner and outer race data when the slide is set to the required shaft diameter. The Selectograf then gives the catalog number of outer and inner races; bearing O.D., tolerances, and width; load capacity at 0 and 100 r.p.m. and in oscillation; housing bore and tolerances; and maximum fillet for shaft and housing.

The other side of the Selectograf gives outer race data when slide is set to the inner race O.D. or shaft diameter. Engineers and designers may obtain the Selectograf free of charge by request on their business letterhead to Bantam Bearings Corporation, South Bend, Indiana.

Low-Pressure Flow Transmitter

THE new Cochrane Style H transmitter, used in conjunction with standard Cochrane electric meter receiving units, is designed specifically for the measurement of low static pressure gases where low differential and resultant low permanent pressure loss is of prime importance.

Differential pressure created by flow is applied to the opposite sides of the oil-sealed bell with the pressure from the connection before the primary element being applied under the bell and the downstream pressure above the bell. A metallic displacer in the central reservoir is submerged in mercury to a point where the bell and displacer just float when no differential pressure is exerted. A flow of gas resulting in a change of differential pressure raises the bell, lifting the displacer from the mercury with the change in buoyancy being just sufficient to give a bell movement proportional to the differential pressure. The translation of bell movement to uniform-chart readings is accomplished by the individually calibrated cam common to Cochrane receivers.

The Style H transmitter is designed for differentials of 2, 4, 6, 8, or 10 in. of water. Standardization of design permits altering the differential head by changing the displacer and amount of mercury in the central reservoir. The bell casing is designed for a maximum working pressure of 75 lb. per sq. in.

Differential pressure in excess of the design differential will move the bell to its upper limit, and the gas will bubble out from under the bell with relatively little disturbance because of the large volume of bell in comparison to the size of high-pressure inlet pipe. Normal operation of the meter is resumed upon the differential falling to normal values.

Ease of accessibility to the transmitter interior permits quick and thorough cleaning of all parts, an operation often made necessary on blast furnace and coke oven gases. Sealing oil level can be quickly checked through the filling plug without removal of the top cover. The same mounting bracket can be used in either wall or floor mounting of the unit.

Fire Blanket

ONE of the most widely-accepted first-aid practices for saving the life of a person whose clothing has become ignited is to wrap the person in a blanket and thus extinguish the flame by smothering it.

Theoretically, this is excellent advice; but in actual practice it presents several serious difficulties. In the first place, a blanket is seldom available within easy access in a manufacturing plant, and quick action is vital to this method of extinguishing fire. In the second place, it often happens that the person attempting to wrap the blanket around the victim is burned himself; and finally, when it's a case of greasy, oil-soaked work clothes catching fire, the heat is sometimes so intense that the blanket itself catches fire, when not expertly used.

As a fool-proof solution to this increasingly important problem, C. Walker Jones Company, of East Germantown, Philadelphia, Pennsylvania, has developed the Jomac Fire Blanket —a specially-knit, flexible blanket that is 100 percent flame-proof, regardless of the intensity of the fire. These blankets are available in attractive, flame-proof containers that may be hung on the wall beside fire-extinguishers, in first-aid stations, or in the equipment provided for air-raid wardens, thus making available effective, on-the-spot protection wherever there is the danger of a workman's clothes being ignited. It is pointed out that of all fire-burns, none results in casualties so often as those involving burning clothing.

THERE'S A GREAT DAY COMING...

Somewhere in England our Norm is fixing QMC trucks. John is piloting paratroopers. Joe's an artilleryman in Hawaii and Red's in an armored regiment in Louisiana. George has become a radio instructor. Chuck left last week for basic training, and Lee was sworn in yesterday. These and others, and others-to-come will do their part in the armed forces. We want them all back, God willing.

But we here don't feel "left behind." For in this kind of Total War we are doing our assignments cheerfully and, we believe, helpfully. Part of our job is to build greater opportunities for Norm and John and Joe, for Red and George and Chuck and Lee and the others — to have things ready, bigger and better, when they come back.

Our courage is high. We are sure of Victory! *There's a Great Day Coming!!*

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE: SAN FRANCISCO, CALIFORNIA, U. S. A. •

A-C. Welding Machine

A NEW a-c. transformer type welding machine that combines safety with operating efficiency, is announced by Wilson Welder and Metals Company, Inc., 60 East 42nd Street, New York, New York. The most interesting feature of the new Wilson "Bumble Bee" a-c. welder is its low open circuit voltage of 42 volts, automatically and positively maintained by means of recent Wilson engineering developments.

Two primary coils are used instead of the usual one, with a magnetic contactor in the circuit of one primary. Each primary contributes approximately 42 volts to the total open circuit voltage, which is actually 84 to 85 volts. When the machine is idle one primary is automatically cut out, however, restricting the open circuit value to 42 volts. As soon as the electrode contacts the work, the second primary is thrown into the circuit, and if there were not a dead short, the voltage would be 84-85 volts.

When the operator draws an arc, this open circuit potential of 84-85 volts enables him to establish his arc quickly and begin welding. Most welding operations are performed at between 32 and 40 volts. When welding is completed and the operator pulls out or lengthens his arc, the arc voltage rises. The moment it reaches 45 volts, the contactor opens and cuts out one primary, leaving only 42 volts in the open circuit.

Several other improvements also are incorporated in the new Wilson "Bumble Bee". Power factor correction is provided with built-in capacitors on all four sizes—300, 500, 750, and 1000 amp.—resulting in a power factor of 100 percent to 86 percent (lagging) over the popular working range. With Wilson's new wiring arrangement, capacitors are cut out when the machine is idle thereby conserving power and reducing costs.

Additional features of the new Wilson "Bumble Bee" contribute to its life, performance, and appearance, it is stated. It is portable and streamlined, and its 18-in. width permits easy passage through narrow doors. It has dual voltage for either 220 or 440 volts and thermal overload protection provided by a cutout coil buried in the winding. A single hand wheel control gives an infinite number of current adjustments throughout the NEMA range.

In This—The Great Emergency—

CLEVELANDS

As Always—Are Coming Through!

When there is ditch to dig.... or fill....
You'll always be glad you bought a
"CLEVELAND"
Keep them in fighting trim by regular attention to maintenance and lubrication.

Ply Garb

A NEW type of protective clothing known as Ply Garb, is announced by the Milburn Company, Detroit, manufacturers of Ply creams and liquids for the prevention of industrial dermatitis. In both design and material, Ply Garb sleeves and aprons are an innovation that provides an exclusive combination of advantages for workers exposed to water, acid, fire, alkalis, and chemicals of all kinds.

Ply Garb fabric was designed to supplement the use of Ply creams and liquids in operations where the exposed skin is subject to abrasive action or where the protection of clothing is of prime importance. Of vital significance is the fact that Ply Garb is flame-proof, preventing serious injury from spontaneous magnesium fires, and other hazardous manufacturing operations.

Made of featherweight, but extremely tough plastic laminated cotton cloth, Ply Garb sleeves and aprons offer maximum comfort and freedom of movement. The sleeves feature special air vents to guard against excessive perspiration. Adjustable shoulder straps make it easy to fit the aprons to the individual. The aprons are available in both full-front and split-front models. In the latter, the garment may be fastened around the thighs and legs in a manner similar to cowboy chaps.

Ply Garb is sturdy enough to resist tears, snags on rough surfaces, and cracking, the manufacturer states. It is flexible enough, however, to resist wear and afford complete comfort. Ply Garb aprons and sleeves are made for both men and women, with each detail of

design and manufacture complying with the recommended specifications of the United States Department of Public Health for the most effective protective clothing.

Substitute for Corrugated Steel Sheets

RAGS and resin have been combined into a war emergency building material substitute for corrugated steel sheets. Called corrugated asphalt siding, the new product was recently placed on the market by The Celotex Corporation, Chicago, Illinois, and is being used both for government and private construction.

The new product is designed for wartime application on industrial, commercial, and farm buildings. It can replace corrugated steel sheets used for covering outside walls of temporary structures of all kinds, including factory buildings, warehouses, storage and machine sheds, dairy barns, and drying sheds.

Corrugated asphalt siding consists of two sheets of heavy felt saturated with a recently developed resino-bituminous compound. The sheets are bound together with a high melting-point asphalt adhesive and corrugated under high pressure.

The finished sheets are hard, rigid, light in weight, and moisture-proof. They retain their stiffness and corrugations in summer weather because of the high melting-point, wear-resistant resins used in the saturating process. No critical raw materials are required, according to the manufacturers.

Corrugated asphalt siding weighs approximately 12 ounces per sq. ft. It is available in five sizes—28 in. by 6 ft., 7 ft., 8 ft., 9 ft., and 10 ft. It is applied in the same general manner as corrugated steel sheets.

The life of corrugated asphalt siding can be prolonged indefinitely by coating or painting immediately after application and every few years thereafter, according to the manufacturers.

Speed Warden

DESCRIBED as "a help for motorists in overcoming the ingrained habit of fast driving" in complying with the 35-mile-per-hour conservation level, a new "speed warden" device has been developed by the B. F. Goodrich Company, it is announced by John L. Collyer, president.

Collyer estimated that 100 percent observance of the 35-mile limit in the next 12 months would mean that the tires on the nation's 27,000,000 private passenger cars would keep cars rolling 31 billion miles farther than could be expected under normal speed conditions.

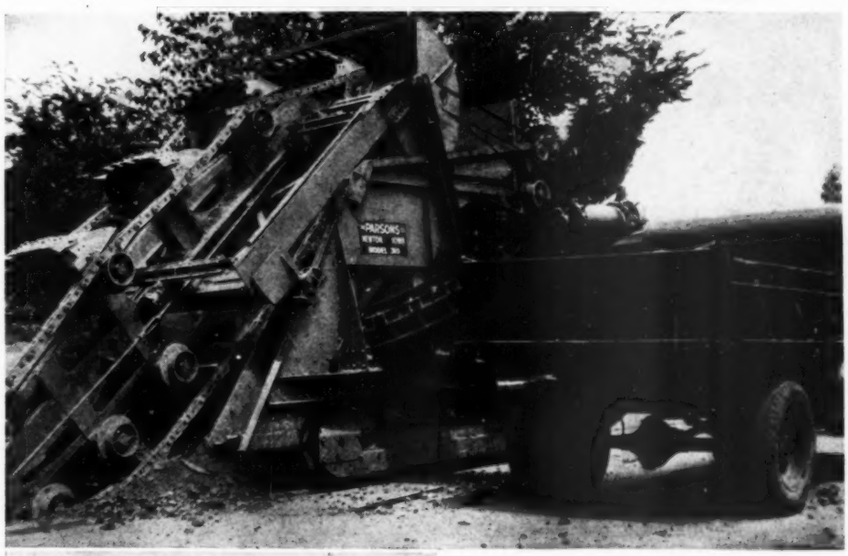
He explained that the "astonishing figure on potential savings" was calculated on the basis of the OPA's recommended 2880-miles per car per year, which would mean a national total of about 78 billion miles. The service from tires needed to deliver this mileage, Collyer explained, would be prolonged nearly 40 percent by nationwide observance of the 35-mile maximum, as made clear by the Baruch report.

"The 'speed warden' has been developed in order to help drivers get maximum mileage from present tires," Collyer said. "Maximum conservation of rubber now in use is the key to the successful bridging of the gap until tire replacements can be made available without drawing upon supplies urgently needed for military uses."

The device can be installed on all accelerator pedals, it was stated. It is easily adjusted on a level road so that the driver knows when the car has reached the 35-mile speed. Use of the "warden" does not prevent the use of extra speed for safety in emergencies, it was emphasized.

"It is a device to enable motorists to observe Rubber Administrator Jeffers' recent request to drivers to 'be your own policeman'," Collyer said.

PARSONS



QUICK SHIFT CONVEYOR

The arc type discharge conveyor on a Parsons Trencher shifts through the machine by power so that spoil may be deposited on either side of trench as desired by the operator. This shift may be made in less than fifteen (15) seconds so that an obstruction can be cleared while machine is digging—a most important feature when operating in close quarters. The shift is by worm and worm gear which automatically locks conveyor in any position.

The conveyor is permanently located for height and does not vary when boom is raised or lowered. Trucks may, therefore, be loaded at fixed position discharge height.

The spoil to be retained for backfill is piled on opposite side of trench by merely moving a lever to reverse the direction of belt. Investigate Parsons superiority before you buy.

When desired a conveyor extension may be added to facilitate loading higher trucks or keep spoil bank farther from trench.

☆ ☆

At least 10% of The Parsons Company payroll is invested in Victory Bonds.

THE PARSONS COMPANY • NEWTON, IOWA

TRENCHING EQUIPMENT

Gem-Quality Synthetic Corundum

SYNTHETIC white sapphire — the mineral corundum unpigmented and of gem quality — is now available in the form of boules from The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation. The boules, the form in which the sapphire is manufactured, each weigh at least 150 carats and are of a regular cylindrical shape, enabling gem cutters to standardize on cutting and sawing procedures. The material, as now made, is practically perfect, any imperfections being microscopic in size and having no effect whatever on the quality of the material for precision bearing surfaces and other essential industrial parts.

Instigated by the need of a domestic source of industrial gems, the manufacturer in less than two years equalled and, in some respects, has surpassed the quality of European gems, formerly the only synthetics obtainable. Since domestic production began, it has grown so that it is now capable of handling the entire military demand for all the United Nations.

Mineralogically, the hardness of the American white sapphire is exceeded only by the diamond. Once they are cut, the jewels are also surprisingly tough in terms of resistance to breakage by impact. Moreover, because they have a melting point of over 3700°F., they are also heat resistant to a high degree. An additional advantage is the boules' uniformity of size and shape, which leads to economical cutting.

Many essential uses are already being made of jewels cut from these synthetic boules. Among locations where they serve economically are as the jewel bearings of chronometers, compasses, and electrical, fire-control, and aircraft instruments. In such instruments, they are employed in the form of ring bearings or V-type and cup-type end bearings. Pallets are also made for watch escapements.

Other successful although still experimental uses of the white sapphires are as thread guides in the manufacture of rayon, as orifices for flow meters and oil-burning equipment, and as insulators in gas-filled or vacuum thermionic devices. Indications are that they are also suitable for use as Diesel-engine injector nozzles, as rollers for small needle bearings, and for cutting tool tips to perform high speed finishing operations on certain non-ferrous metals. Their complete chemical inactivity when exposed to all types of corrosion except strong mineral acids and alkalies may suggest additional uses to designers of chemical equipment.

Further information on these gems is obtainable from The Linde Air Products Company, 30 East 42nd Street, New York, New York.

"Motor Finder" Helps Select Proper Motor

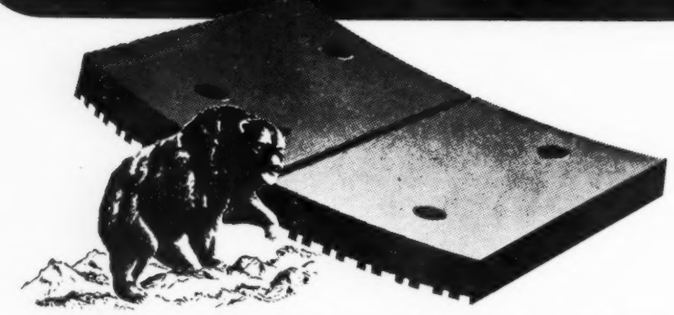
To help motor users fill their wartime motor needs with the least possible delay, as well as conform to recent WPB recommendations, Allis-Chalmers now offers a new "Motor Finder" for quickly selecting the various types of squirrel-cage motors.

With the new "Motor Finder" slide-rule, the motor user is able to match the conditions under which the motor must operate at the proposed installation with the required motor characteristics and instantly learn the right motor type and its features.

Only three steps are necessary to select a motor. As more than 30 standard types, covering a range in horsepower from ½ to 75, are included in the Allis-Chalmers Lo-Maintenance line, all characteristics of versatility of squirrel-cage motors are immediately considered in using the slide-rule.

Copies of the new slide-rule can be obtained free of charge on request from Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

Speed Up DRILLING OPERATIONS With GRIZZLY



Maximum ton miles of service . . . with large savings in time, labor and production.

Grizzley's fast, sure brake action is geared to the high speed, deep drilling operations of today's wartime activities. It stops smoothly, without jerking, grabbing or smoking; and holds the heaviest loads safely at any depth. Brake and drum troubles are reduced to minimum. Ask your supply dealer for records of Grizzly service.

GRIZZLY MANUFACTURING COMPANY
Formerly E. M. Smith Co.
Plants: Los Angeles, California — Paulding, Ohio
Complete Stocks Maintained in our Warehouses at:
407 Velasco Street, Houston, Texas
1621 East Yellowstone, Casper, Wyo. — 1008 S. E. 29th St., Oklahoma City, Okla.
Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York, N. Y.
Distributed by Leading Supply Companies

GRIZZLY ROTARY BLOCKS

F. H. Payne, President American Meter, Passes Away

Francis Hervey Payne, president of American Meter Company, and manager of the corporation's Metric Metal Works Plant at Erie, Pennsylvania, died November 10 while attending the monthly meeting of the Men's Club at St. Paul's Church, Erie, Pennsylvania. He was in his 75th year.

FRANCIS H. PAYNE

Payne was born April 1, 1868, at Petroleum Center, Venango County, Pennsylvania, where his father, the late Calvin N. Payne, was engaged in drilling for oil and built the first natural gas pipe line in America.

Francis Payne was a graduate of the Titusville High School, the Hill School of Pottstown, Pennsylvania, and of Princeton University, Class of 1891.

His advent into the gas meter business was in July, 1891, when he became secretary and manager of the Metric Metal Company then at Beaver Falls, Pennsylvania.

Payne enjoyed an unbroken record of almost 52 years as manager of this important operating factory, which became a part of American Meter Company when that company was organized in 1895.

He was a director of this corporation for many years prior to his election as vice-president in 1923, and as president in June, 1936.

Payne had an active interest in the civic affairs of his home community, and at the time of his death he was a director of the American Gas Association, the Erie Chamber of Commerce, and the Erie County Health and Tuberculosis Association, and president of the Board of Library Trustees, Erie, Pennsylvania.

He was a director of the First National Bank of Erie for many years, and chairman of the board of the National Bank and Trust Company.

He was a member of the Uptown Club of New York, the Kahkwa Club of Erie, and of many clubs and organizations.

On the occasion of Payne's 50 years' service with American Meter Company on June 20, 1941, a testimonial dinner was tendered him at the Kahkwa Club in Erie by the directors, officers, and members of the company.

Important manufacturing history in the measurement of gas and oil was made during Payne's many years of management of the Metric Metal Works plant. In 1891, tinned steelcase gas meters, extensively used throughout the United States since 1836, were first made from dies. High-pressure ironcase meters were also developed and improved from 1888 until the present. In 1916, Ballard Westcott orifice meters were developed. This principle of orifice measurement is extensively used in recording the large volume flow of gases and liquids in the gas and petro-chemical industries.

Payne is survived by his widow, Mrs. Myra Lee Payne, and two sons, F. Dana Payne and Calvin N. Payne, II, also by a sister, Mrs. Axtell J. Byles, and a brother, Christy Payne, who, before his retirement, was treasurer of the Standard Oil Company of New Jersey.

CONSERVE Your BRAKE LININGS
with these tested methods

THESE SUGGESTIONS are presented by Johns-Manville as time-tested ways of conserving equipment and of increasing the life and performance of brake linings.

1 Increase air flow around clutches and brakes to assure maximum heat dissipation

2 Check bands for being out of round or kinked when relining

3 Be sure that brakes and clutches are properly adjusted to eliminate unequal wear

4 Never use oil, clay or other foreign substances on linings to control friction

For further suggestions on friction materials and on more efficient use of packings, insulations, roofings and refractory cements, write for the new J-M manual, "101 Suggested Good Operating Practices." Johns-Manville, 22 E. 40th St., New York, N. Y.

For Maximum Efficiency, Start Rigs Right* with
JM Johns-Manville 420 ROTARY LINING
Write for Catalog FM-10A

Frank J. Weschler Called by Death

Frank J. Weschler, vice-president of the Chain Belt Company, Milwaukee, Wisconsin, and general manager of Baldwin-Duckworth, a division of Chain Belt Company at Springfield and Worcester, Massachusetts, died November 10 in Worcester.

Weschler has been exceedingly active in the industrial life of Springfield, Worcester, and Massachusetts. Born in Erie, Pennsylvania, he moved east in 1902 to take a position with the cycle industry. In 1906 he became affiliated with the Hendee Manufacturing Company, now the Indian Motocycle Company, as sales manager. In 1909 he became clerk of that corporation, treasurer in 1910, vice-president and general manager in 1922, and president in 1923.

In 1927, Weschler became affiliated with the Baldwin Chain and Manufacturing Company of Worcester, as president and treasurer. Upon the merger of that company with the Duckworth Chain and Manufacturing Company in 1930, he became treasurer and general manager of the newly formed Baldwin-Duckworth Chain Corporation. When Baldwin-Duckworth merged with the Chain Belt Company in 1939, Weschler became vice-president of Chain Belt Company, and general manager of Baldwin-Duckworth, which is now a division of the Chain Belt Company.

FRANK J. WESCHLER

Weschler was an executive whose ability was recognized widely. He had been a vice-president of the Associated Industries of Massachusetts, a director of the Chamber of Commerce, and had been appointed to directorship in a number of banks.

Reilly Primer and Pipe Enamel

Reilly COAL TAR PRODUCTS

17 PLANTS to Serve the Nation

● The dependable protection which REILLY coatings give to metal surfaces has been demonstrated in years of service—under the most severe conditions of soil and weather. As an outside coating on water mains, oil and gas pipe lines, REILLY Enamel prevents corrosion from moisture, electrolysis, soil acids and alkalies; resists abrasion and soil stress, and withstands wide extremes of temperature. On the inside of water mains, the smooth, mirror-like REILLY lining prevents incrustations and tuberculation, and assures permanent full-capacity flow. . . . REILLY coal tar paints give effective and economical protection to tanks, stacks, structural steel and other metal exposed to atmosphere, corrosive gases and vapors. Booklet describing these protective coatings will be sent on request.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

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SEVENTEEN · PLANTS · TO · SERVE · YOU

New Officers Acetylene Association

Newly elected officers of the International Acetylene Association, chosen at the annual meeting held in Cleveland, Ohio, are: Ellsworth L. Mills, president; Glenn O. Carter, vice-president; Herbert F. Reinhard, secretary, and Philip Kearny, treasurer.

Mills is vice-president of the Bastian-Blessing Company, Chicago, Illinois, manufacturers of oxy-acetylene welding and cutting equipment. He has been active in the acetylene industry and in the affairs of the I.A.A. for many years and has previously served as vice-president and director of the association. He is a native of Denver, Colorado, and a graduate of Cooper Union, New York City.

Carter is a consulting engineer with The Linde Air Products Company and a member of the executive board of the Compressed Gas Manufacturers' Association. Reinhard, who will serve as secretary for the eleventh time, is associated with Union Carbide Corporation, New York, New York. Kearny, who has previously served as a director, vice-president, and president of the association, is president of the K-G Welding and Cutting Company of New York City.

Newly elected directors, who will serve for three years, are Henry Booth,

vice-president, Shawinigan Products Corporation, New York City; E. L. Mathy, vice-president, Victor Equipment Company, San Francisco, California, and R. B. Swope, president, Southern Oxygen Company, Inc., Arlington, Virginia. In addition, the following will continue to serve as directors: Elmer H. Smith, Smith Welding Equipment Corporation, Minneapolis, Minnesota; H. P. Dolisie, Canadian Liquid Air Company, Ltd., Montreal, Canada; C. D'W. Gibson, Air Reduction Company, Inc.; C. O. Epperson, National Cylinder Gas Company, Chicago; W. C. Keeley, National Carbide Corporation, and H. S. Smith, Union Carbide and Carbon Corporation.

Members of the executive committee of the association for next year are: H. S. Smith, Gibson, and Kearny.

Army-Navy "E" Awarded Macwhyte Employees

Official recognition for excellence in the production of war materials has been received by the employees of Macwhyte Company, Kenosha, Wisconsin, from Robert B. Patterson, Under Secretary of War.

This high honor, not easily won nor lightly bestowed, was recommended by the Procurement Officers for the Army and the local inspector of the Navy. This recommendation was made because of the high quality and quantity of production by Macwhyte co-workers for the Army and Navy.

The award was made as of November 21 and is given to all men and women employed by Macwhyte Company on that date. Honorable Robert B. Patterson, Under Secretary of War, said—

"To the Men and Women
of the Macwhyte Company,
Kenosha, Wisconsin.

"This is to inform you that the Army and Navy are conferring upon you the Army-Navy Production Award for your fine record in the production of war equipment.

"The award consists of a flag to be flown above your plant and a lapel pin which every man and woman in your plant may wear as a symbol of high contribution to American freedom.

"This award is your nation's tribute to your patriotism and to your great work in backing up our soldiers on the fighting fronts. I have full confidence that your present high achievement is indicative of what you will do in the future."

Plans are under way for a special ceremony at which Army and Navy officers will present the award. The time and place of the ceremony will be announced later.

The products of Macwhyte Company are wire rope, braided wire rope slings, cable, cable ends, cable assemblies, and tie rods for aircraft.

New Abrasive Cutting Book Available to Industrial Men

Just off the press is a complete, up-to-the-minute book called "Abrasive Cutting", which explains the development and application of abrasive cutting. Andrew C. Campbell Division of the American Chain and Cable Company, Inc., Bridgeport, Connecticut, offers this book to industrial men without cost.

In this 32-page book there are ample details, photographs, and tables concerning the operation of abrasive cutting machines. This is not a catalog, the manufacturer explains. It follows the development of these machines from the dry abrasive cutting machine right up to the most modern wet abrasive cutting machine on the market today.

Typical of the material found in the book are these chapters: Advantages of abrasive cutting, comparison of wet and dry cutting, principles governing abrasive wheel efficiency, effect of wheel speed on wheel efficiency, and important abrasive cutting tables.

For a copy of "Abrasive Cutting" write to Andrew C. Campbell Division, American Chain and Cable Company, Inc., Bridgeport, Connecticut, Attention Sales Promotion Department.

Season's Greetings

from Gulf States

General Offices: Beaumont, Texas; Baton Rouge and Lake Charles, Louisiana.

DEPENDABLE
GULF STATES UTILITIES CO.
PUBLIC SERVICE

Brief Illness Fatal to Marmon-Herrington Official

John J. Klein, assistant secretary of The Marmon-Herrington Company, died recently at St. Vincent's Hospital after a four days' illness from pneumonia. Klein was born in New York City on June 21, 1910. He graduated from the Fordham Preparatory School in 1928; from the Stevens Institute of Technology, Hoboken, New Jersey, in 1932, and from the Fordham University School of Law, New York City, in 1935. He was a member of Delta Tau Delta Fraternity.

Klein's education and experience represented that rare combination of legal and engineering training that brings so much to American industry.

Prior to going with the Marmon-Herrington Company he was a member of the legal firm of Klein, Kinsey and Klein of New York City, and was admitted to practice before the bar in the State of New York, the State of Indiana, and the U. S. Supreme Court.

Klein was a member of the Society of Automotive Engineers.

Previous to his appointment as assistant secretary of the Marmon-Herrington Company he served in the capacity of assistant to A. W. Herrington, chairman of the board of directors, then president of the company. His appointment to be assistant secretary of the organization was in recognition of the faithful and effective service he rendered as assistant to the president.

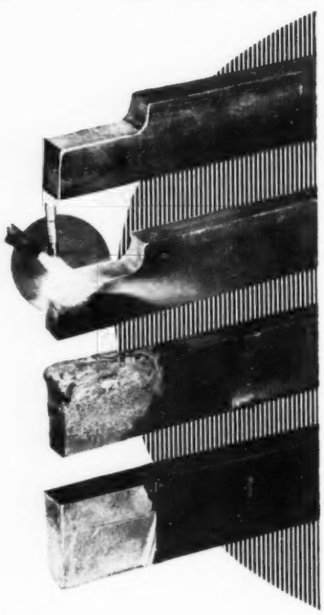
Surviving are a sister, Miss Ida Klein of New York City, and two brothers, August, an attorney practicing in New York City, and Dr. Carl P. Klein, of Beecher, Illinois, all of whom were at the bedside.

Funeral services were held in New York City.

MAKE YOUR OWN CUTTING TOOLS

with the new

COLMONOY WCR ALLOYS



● Bridge the gap between high speed steel and the carbides. Reclaim old, and make new cutting tools by welding. The process is simple. To fabricate a typical tool—

1. Undercut carbon steel shank, leaving a fillet for ease in welding.
2. Fill undercut, using ordinary hard facing welding procedure.
3. Hot wipe, to approximate shape, to save grinding.
4. Wet grind, using green silicon carbide rough and finish wheels.

WRITE FOR LITERATURE

Immediate delivery of all grades of W C R Alloys at all branches.

WALL-COLMONOY CORP.

720 Fisher Building, Detroit, Michigan

Branch Offices

NEW YORK CITY; BLASDELL, N. Y.; CHICAGO; TULSA; LOS ANGELES, CALIF.

Other Branches in Canada

COLMONOY

Hard Surfacing Alloys and Overlay Metals

Woobank Pump Opens Houston Office

The Woobank Pump and Machinery Company announces the opening of an office in Houston, Texas, in the Kress Building, to provide more active representation of the products they handle — principally Cook's Graphitic Iron Piston Rings and Cook's Metallic Rod Packings.

The office will be in charge of F. Black, who previously made his headquarters at Fort Worth.

G. D. Gilbert General Manager Baldwin-Duckworth

The Chain Belt Company, Milwaukee, Wisconsin, through J. C. Merwin, president, announces the appointment of George D. Gilbert as general manager of Baldwin-Duckworth. Baldwin-Duckworth, a Division of Chain Belt Company, operates plants in Springfield and Worcester, Massachusetts, manufacturing machine finished roller chain and sprockets.

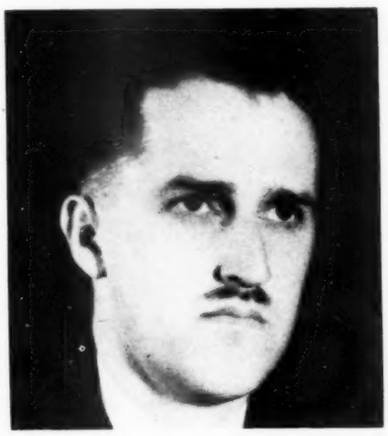
Merwin also announces the appointment of William H. Gates as Works Manager of the Baldwin-Duckworth Division.

Le Roi Employees Exceed Production Quotas

A "distinguished production medal" has been awarded to employees of the Le Roi Company, Milwaukee, Wisconsin, in recognition of their having passed the scheduled production quota three successive months. For months Le Roi Company employees have been striving to produce all they can in as short a time as possible for the armed forces of the nation, and finally succeeded in passing the scheduled production quota three times in a row. It is their intention to keep on passing the quota every month in the future.

J. M. Hait Heads New Division

Designing and building amphibian tanks is a far cry from designing and manufacturing turbine and other types of pumps, but an engineer with a well-prepared, trained, and versatile mind



J. M. HAIT

readily adapts himself to changed conditions and easily carries on with the utmost speed and efficiency.

James M. Hait, for many years chief engineer of the Peerless Pump Division-Food Machinery Corporation, and credited with many of the firsts in pump design, has been working diligently in the development of amphibian tanks for the government during the last year. The results of his efforts have been outstanding.

As a consequence, it has become necessary for Food Machinery Corporation to establish a new division. This new division will be known as Food Machinery Corporation, Division of Procurement and Engineering. James M. Hait, chief engineer of Peerless Pump Division, has been selected as general manager of that division. His services in the design and development of amphibian tanks (the U. S. Marines call these tanks that swim "alligators"), and such other equipment as he is called upon to design, will do much to help win this war.

Named Sales Representative

The Midwest Machinery Company, 8029 Forsythe Boulevard, St. Louis, Missouri, has been appointed sales representative in the southern part of Illinois and the eastern and southern parts of Missouri by the Roto Company, Newark, New Jersey, manufacturers of tube cleaners. This territory was formerly covered by the late W. B. Willson.

Bennet B. Bristol of Foxboro Company Is Dead

Bennet B. Bristol, who with his brother Edgar H. Bristol founded the Industrial Instrument Company, in 1908, which later became The Foxboro Company, died at his summer home at Falmouth Heights, Massachusetts, on Tuesday, November 10, after several months' rest from a heart attack, suffered last May.

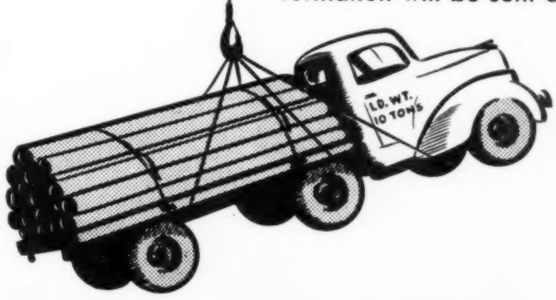
Bristol was born in Naugatuck, Connecticut, May 3, 1868. In 1893 he was graduated, M.E., from the Stevens Institute of Technology. Throughout the history of The Foxboro Company he served as its treasurer and clerk. He was president of the Foxboro National Bank, a director of the Citizens and Manufacturers National Bank of Waterbury, Connecticut, chairman of the board of trustees of the Foxboro State Hospital, and took an active part in the affairs of his church and community. He is survived by a brother and a sister, his widow, his six children, and 19 grandchildren. Funeral services and burial were at Foxboro, Massachusetts.

IMAGINE

Lifting This Load With A String of Rods

Yet, your rods lift such loads hundreds of times — day after day. Which explains why it is so important to clean box and pin ends each time the string is made up; why couplings should always be shouldered solidly with snap wrenches.

Often, however, rod failures are not due to improper care and handling of the string. Such failures go beyond the scope of everyday field practice, and can be determined by a Jones Well Study. These studies reveal—scientifically—*all* the pumping characteristics of a well. Complete information will be sent at your request.

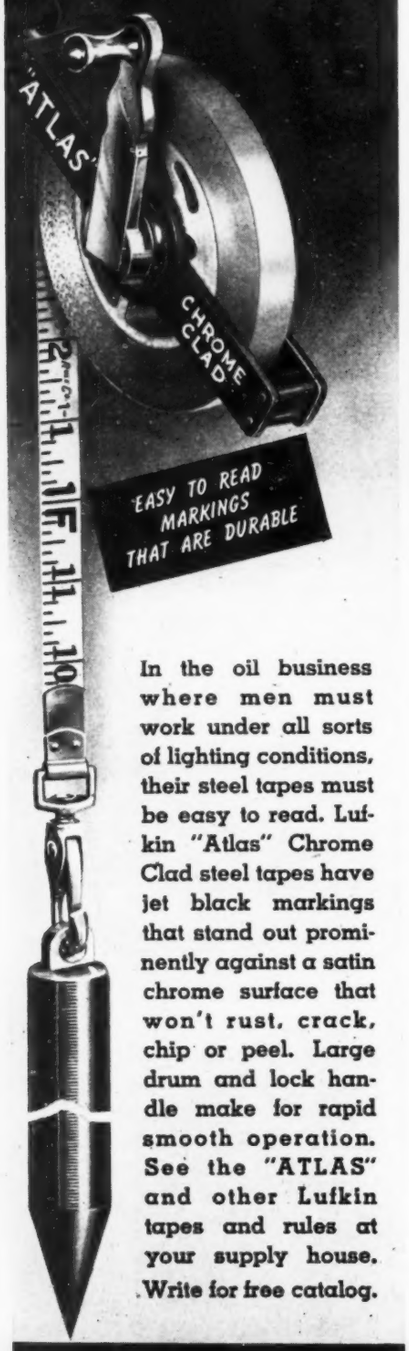


The S. M. JONES Co.

JoneSuckeRods

General Office and Factory, Toledo, Ohio — Sales Office, McBirney Bldg., Tulsa, Okla.

"ATLAS"
CHROME CLAD
STEEL TAPES



In the oil business where men must work under all sorts of lighting conditions, their steel tapes must be easy to read. Lufkin "Atlas" Chrome Clad steel tapes have jet black markings that stand out prominently against a satin chrome surface that won't rust, crack, chip or peel. Large drum and lock handle make for rapid smooth operation. See the "ATLAS" and other Lufkin tapes and rules at your supply house. Write for free catalog.

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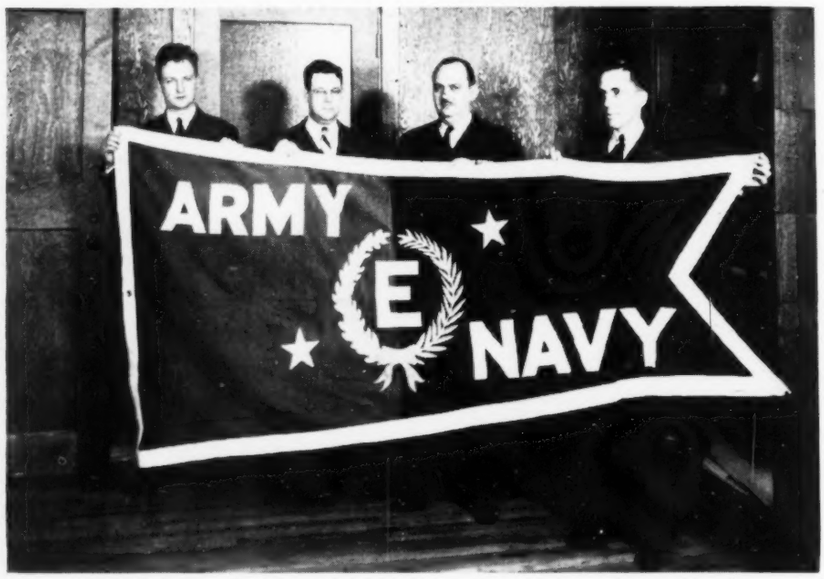
TAPES · RULES · PRECISION TOOLS

Army-Navy "E" With Two Stars to Bantam Bearings

The Army-Navy "E" pennant with two stars, continued recognition for outstanding war production, has been awarded Bantam Bearings Corporation, South Bend, Indiana. The Bantam plant is the first in Indiana and one of four in the entire midwest to receive two stars on its banner for its service in war production.

The presentation was made by Lieut. Commander Richard Wagner, of the United States Navy's Midshipmen School at the University of Notre Dame. It was received on behalf of the company by R. B. Nichols, vice-president and general manager, and Orville Zimmer, president of the Bantam employee's union.



Left to right: Ensign H. B. Miller, R. B. Nichols, vice president and general manager, Lieutenant Commander Richard Wagner, and Orville Zimmer, president of the Bantam C. I. O. local who accepted it on behalf of the company employees.

Kobe Announces Advancement of Rader and Browning

C. M. Rader has been advanced to assistant general manager, and H. K. Browning has been advanced to general sales manager of Kobe, Incorporated. In making this announcement, J. C. Coberly, president and general manager, said these changes were made to meet the increasing demands of the company's business due to its war contracts and rapidly spreading use of the company's hydraulic pumping system for the production of crude oil essential to the war effort.

Rader, formerly general sales manager, will as assistant general manager be responsible for all hydraulic pump and perforated pipe activities of the company, and will continue to make his headquarters in Huntington Park, California. Rader was graduated from the University of Minnesota's school of civil engineering and immediately entered the officer's training course at Fort Snelling, Minnesota, later serving with the Twentieth Engineers in France during 1917 and 1918. On returning to civilian life in 1920, he joined the engineering group of the Mid-West Refining Company and served as district petroleum engineer covering that company's operations in Wyoming, Montana, and Colorado. After a brief experience in general engineering practice in Florida in 1925, Rader returned to his original interest and joined the Indian Territory Illuminating Oil Company as petroleum engineer at Seminole, Oklahoma, later moving to Oklahoma

C. M. RADER

City as assistant to the vice-president and general manager of the company. In 1931 he went with the Phillips Petroleum Company in Oklahoma City as petroleum engineer when the Oklahoma City field was presenting its first of many difficult production problems. In 1937 Rader, having become thoroughly interested in the possibilities of hy-

H. K. BROWNING

draulic oil well pumping, joined Kobe, Incorporated, as Mid-Continent Division manager, which position he held until April of this year when he was made general sales manager of the company and moved to Huntington Park.

Browning as general sales manager will have charge of all the company's sales, field, and advertising activities in both the domestic and foreign markets for all products, and will make his headquarters in Huntington Park.

After attending the school of civil engineering at Cornell University, Browning joined the A. M. Byers Company of Pittsburgh in the position of manager of oil country sales, in which position he was quite active in technical sales work. Interest in pumping and corrosion problems caused his association in 1934 with the S. M. Jones Company as sales manager, a position he held for five years.

Browning joined Kobe, Incorporated, in 1940 as division sales manager, and in April of this year replaced Rader as Mid-Continent Division manager on the latter's transfer to Huntington Park as general sales manager.

Elected to Tide Water Board

Thomas A. J. Dockweiler has been elected to the board of directors of Tide Water Associated Oil Company, succeeding the late George N. Armsby. Dockweiler is a resident of Los Angeles, California, and prominent in law and business circles on the Pacific Coast, is counsel for several oil companies, and otherwise interested in the oil industry.

OTIS TYPE G
SIDE DOOR CHOKE

With the versatility of a B-24 Bomber the Otis Type G Choke simplifies the completing and production of Two Zone Wells.

Entrance of fluid into the tubing from either or both pays can be regulated by means of Ports in the Removable Otis Type G Choke. The ports in the choke landing nipple can be blanked off or opened as desired, thereby providing a means to:

1. "Bring in" the annulus after the well surface connections have been hooked up and tied down.
2. Take Bottom Hole Pressure of each formation independently of the other.
3. "Kickoff" the Annulus should it become loaded up.

These operations can all be accomplished under pressure without moving the tubing or breaking the packer seal. By equipping the choke with a blank cup mandrel which has an open bore, the upper formation is blanked off, and the tubing becomes a conductor for the lower pay only. Conversely, if an orificed cup mandrel is used with its lower end plugged, the lower formation is blanked off and the tubing becomes a conductor for the upper formation only. This latter arrangement provides a means to circulate fluid above the packer without raising the tubing or breaking the packer seal.

The Type G Choke is run and pulled under pressure on an ordinary steel measuring line.

WRITE FOR COMPLETE INFORMATION

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DALLAS, TEXAS

Branches: Houston and Corpus Christi, Texas; Hobbs, New Mexico; New Iberia, Louisiana; Magnolia, Arkansas

Representatives: Otis Eastern Service, Inc. Wellsville, New York; Western Pressure Control, Los Angeles and Bakersfield, California

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MAXIMUM EFFICIENCY
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—for resuscitation

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NATIONWIDE SALES AND STOCKS

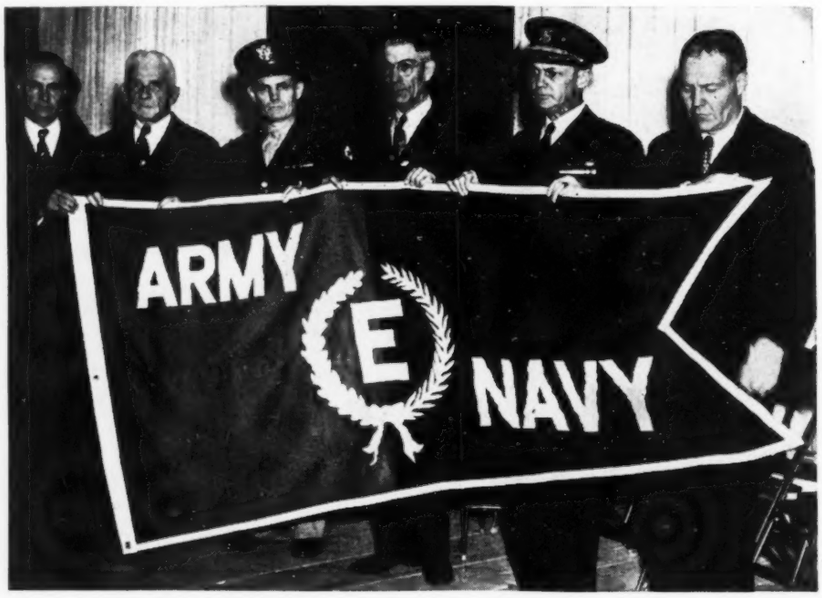
Bucyrus-Erie Wins Army-Navy "E" Award

In a ceremony highlighted by an impressive salute to members of the armed forces who have given their lives in the service of the country, officers of the Army and Navy presented the coveted Army-Navy "E" award to the Bucyrus-Erie Company's South Milwaukee Plant recently.

Brig. General G. M. Barnes, U. S. Army Ordnance Department, unfurled the "E" banner and paid tribute to the outstanding record of production achieved by the company. Captain D. D. Dupree, U. S. Navy, decorated employees with red, white, and blue "E" buttons for accomplishments "above and beyond the call of duty".

Addresses in behalf of the company were made by W. W. Coleman, president, N. R. Knox, vice-president, and Robert Scott, representing the employees.

In addition to the production of its regular dirt-moving equipment for use in a wide variety of building activities directly concerned with the war effort, Bucyrus-Erie is engaged directly in manufacturing ordnance material.



From left to right, the men holding the pennant are: Louis Quarles, who presided at the ceremonies; W. W. Coleman, president of Bucyrus-Erie; Brigadier General G. M. Barnes, of the Army Ordnance Department, who made the presentation; Robert Scott, employees' representative; Captain Dallas D. Dupree, U. S. Navy, who decorated the employees with "E" buttons, and N. R. Knox, vice-president of Bucyrus-Erie, who accepted the award.

Death Calls H. R. Gruber

H. R. Gruber, who until his retirement, was vice-president and general sales manager of the Union Wire Rope Corporation, Kansas City, Missouri, died recently at his home in Chanute, Kansas. Burial was in Tulsa, Oklahoma, where he resided for 31 years prior to moving to Chanute last January.

Early in his business career Gruber was affiliated with the Oil Well Supply Company at Jacksonburg, Mannington, and Sistersville, West Virginia. Before going with Union Wire Rope Corporation he had been associated with the Muskogee Tool Company and the Williamsport Wire Rope Company.

Gruber at one time was chairman of the Oil Timers' committee of the International Oil Exposition.

Surviving are a daughter, Mrs. H. M. Humphrey, Ann Arbor, Michigan; three sisters, Mrs. H. C. Bodley, Chanute; Mrs. F. M. Roome, Mattoon, Illinois, and Mrs. J. F. McGinley, Abilene, Texas. He also is survived by a brother, W. W. Gruber, San Angelo, Texas.

H. R. GRUBER

Morgan in Charge of BJ Export Office

The Oil Tool Division of Byron Jackson Company announces the appointment of O. W. (Ox) Morgan as manager of its New York Export Office, in

O. W. MORGAN

the Graybar Building, New York City.

Morgan has been associated with the Oil Tool Division of the company for many years in California, Oklahoma, Texas, Louisiana, Kansas and Illinois, and is well qualified to promote sales at this time and to develop plans for post war business.

Byron Jackson Company also has appointed S. F. Remmel as representative of the Oil Tool Division in Wash-

S. F. REMMEL

ington, D. C., with headquarters at the Brighton Hotel. Remmel is widely known in California, where he was sales manager, and will be remembered also by foreign visitors to California during the last few years.

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Works havoc in your pipes, boilers and heat exchangers
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Makes itself at home and plugs up your pipes and tubes
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3
Fights hard to keep you from getting water necessary for production
OILY BOILER DEPOSIT
4
Eats up power and bags your tubes

We conserve metals difficult to replace. We have solved the condensate corrosion problem in steam systems. In the Cook County Nurses' Home in Chicago, where extra heavy wrought iron piping withstood corrosive condensate only thirty days, Haering Glucosates corrected the condition, and test pieces six months later were free from corrosion deposits. We protect metals in boilers, piping, condensers and heat exchangers, too.

The Glucosates also conserve energy. Less fuel is needed—more production obtained—where Glucosates control scale, corrosion and living organisms. The Glucosates save raw materials too. Less chemicals are used where Glucosates substitute for common inorganic materials.

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IN EVERY Vortox Air Cleaner there is a special sump for holding all dust and grit. This sump traps the dust and prevents it from ever again contacting incoming air. Moreover, because the all-metal filter element is constantly washed by oil spray, the filter cleans the air without collecting quantities of dirt. As the filter remains clean, due to the vigorous scrubbing action of the oil, there is no tendency to clog and restrict air flow.

These features are highly important. They cut maintenance to the core, because a single operation — simply changing the oil — is all that's required to remove all dirt from the cleaner. They reduce replacement costs too, because there is nothing to wear out and require replacement. *And greater engine efficiency results because a Vortox is always giving maximum protection regardless of dust load.*

Vortox Air Cleaners not only give you *more* protection that effectively cuts engine maintenance, but give you air intake silencing and back-fire arresting as well — at no extra cost! Investigate the many other advantages of Vortox protection — today.

VORTOX provides maximum air cleaning

VORTOX MANUFACTURING CO.
CLAREMONT · CALIFORNIA

VORTOX OIL TYPE SELF-WASHING AIR CLEANER

Look for the Arm and Hammer

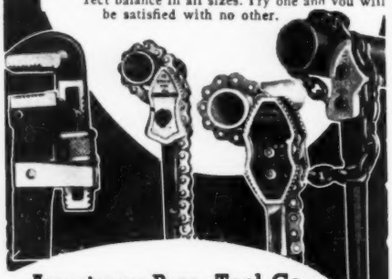
ARMSTRONG BROS.

PIPE TONGS

Not only the type Tongs you want in the size and design you prefer — but the quality that distinguishes an "ARMSTRONG BROS." PIPE TOOL.

Chain Tongs with handles forged from high carbon steel, Drop Forged jaws with milled teeth, hardened, tempered and tested for wearing qualities, large Hardened Steel Bolts, Alloy Steel Shackles, proof-tested Chains, and the ARMSTRONG Design that gives far more bearing of jaws on bar.

All-Steel Pipe Wrench. This patented all-steel pipe wrench has 10 improved features including—elimination of cumbersome housing. Heavy forged-in lugs reinforced by reversed nut to take up side strain. Replaceable tool steel jaws. Perfect balance in all sizes. Try one and you will be satisfied with no other.



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Pneumonia Fatal to D. W. Haering

The many friends of David W. Haering, president of D. W. Haering and Company, Inc., were shocked to learn of his death after a brief two-day siege of pneumonia. Haering was taken ill on Thursday and died at the West Suburban Hospital in Oak Park on Friday, October 30, 1942.

David Haering was born in Chicago on February 3, 1908, the son of George Victor and Elizabeth S. Haering. He attended the Chicago grammar schools,

D. W. HAERING

the Austin High School, and was graduated from the University of Illinois in 1929 with a Ph. C. degree. His widow, his father, and two sisters survive him.

D. W. Haering developed the company through a period of depression from a one-man organization into a well-established corporation having headquarters at 205 West Wacker Drive, a factory, control, and research laboratories in Chicago, and technical offices in the principal industrial cities of the United States.

Haering was the president and technical director of the company bearing his name and was also an outstanding authority on scale and corrosion. The company acts as water consultants for many large industrial corporations. Under his direction the research laboratories of D. W. Haering and Company discovered and developed 28 different organic glucosides for the control of scale and corrosion in aqueous systems. The engineering department invented and patented a proportioning machine using the Haering liquid piston principle for proportioning liquids into liquids or gases.

The valuable research and education library of the company, collected under Haering's direction, contains many first editions, and practically every book on water, scale, and corrosion or algae that has been published in the last century.

Why *manpower* should wield the "big stick" in this mechanized age! We are planning an army of 7½ Million in 1943. The drain from industries' 65 Million and the farms' 10 Million workers makes *manpower* the nation's number one problem. The more workers are needed the fewer there are to be had, presenting a problem so vitally important that some means of fortifying this weakening giant is soon due.

It is said that it takes 18 men in the rear to keep one man at the Front. This means that like the cog in a wheel every man must fit in his proper place and "stay put." But that's a job for the *manpower* commission. That it will be solved no one doubts.

It's everybody's job, though, to keep the wheels of war industries rolling so the cogs can fit for the long pull ahead.

Join the "Ten Percenters"
Buy More and More Bonds
Buy Till It Hurts, Then
Buy Some More

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DISTRICT OF COLUMBIA
Hotel Washington.....Washington
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Hotel Faust.....Rockford
LOUISIANA
Jung Hotel.....New Orleans
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MISSISSIPPI
Hotel Lamar.....Meridian
NEBRASKA
Hotel Paxton.....Omaha
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OKLAHOMA
Oklahoma Biltmore.....Oklahoma City
Hotel Aldridge.....Wewoka
SOUTH CAROLINA
Hotel Wade Hampton.....Columbia
TEXAS
Hotel Alice.....Alice
Hotel Stephen F. Austin.....Austin
Hotel Edson.....Beaumont
Hotel Settles.....Big Spring
Hotel Brownwood.....Brownwood
Hotel Southern.....Brownwood
Hotel Laguna.....Cisco
Hotel Cortez.....El Paso
Hotel Texas.....Fort Worth
Hotel Buccaneer.....Galveston
Hotel Jean LaFitte.....Galveston
Coronado Courts.....Galveston
Jack Tar Court.....Galveston
Miramar Court.....Galveston
Hotel Cavalier.....Galveston
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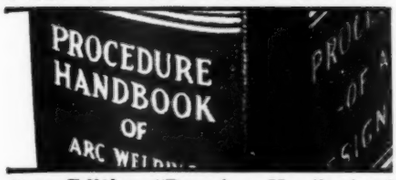
HOTEL GALVEZ . . . Galveston, Texas
Now used exclusively by U. S. Coast Guard.
No guests taken 'til Victory has been won.

Affiliated NATIONAL HOTELS
HOST TO THE NATION
SERVING 10 STATES AND OUR NATION'S CAPITAL

New Book on ARC WELDING



New Edition "Procedure Handbook of Arc Welding." Bigger than ever. Wider in scope. Latest information on all phases of arc welding—the ace process of war production and key to progress and increased earning power in post-war era.

Authoritative. Recognized the world over as the "bible" on arc welding design and practice. Many thousands in use by welders, designers, engineers and shop managers. Standard text in hundreds of schools and colleges.

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U. S. WAR SAVINGS BONDS

Hugh Matier Addresses Los Angeles Nomads

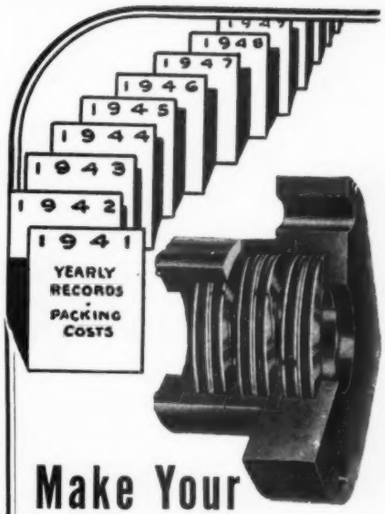
The vital importance of the new Alaska Highway was clearly disclosed at the regular monthly meeting of the Los Angeles Chapter of Nomads, held in Los Angeles on November 18. A brief business meeting followed the dinner, which was so well attended that extra tables had to be set up to accommodate all who were present. President Bill Bettis then introduced the speaker of the evening, Hugh Matier, who, after a most exciting life in many distant

HUGH MATIER

parts of the world, is now in charge of public relations for the Union Oil Company of California.

Matier is a founder member of the Pacific Geological Society and a patron of the Smithsonian Institute. As a geologist for the Union Oil Company he long ago won recognition for his archeological achievements and during the years has travelled to practically every corner of the earth. The subject of his talk was "Alaska, The New Frontier" and, as he has just returned from a three months' trip through Alaska and Canada over the highway opened December 1 and, because in 1908 he made a survey for the Canadian Minister of Lands of the particular route being followed by this highway, he was eminently qualified to cover this subject.

A number of guests were present at the Nomads' meeting and among them were the following men from other countries: B. R. Cunningham of V. O. C. from Venezuela; Frank McAtier who was formerly with the Burmah Oil Company; Meade McCamey of the N. K. P. M.; J. C. Vandenberg of the B. P. M.; Sanford Hall of Burmah Oil Company; E. B. Udlock of Standard of Venezuela; W. F. Parraga of C. A. S. O. C.; John Bryde of Cia Shell de Colombia, and Homer LeFlor of Socony Vacuum of Venezuela.



Make Your Next Packing Job *L-A-S-T !*

During these days of increased production, it is especially annoying and costly to experience shutdowns due to packing trouble.

There is a solution. Install France "Full-floating" Metal Packing in your engines, pumps and compressors. The result is increased efficiency. And each job lasts for years without maintenance expense. Saves money, too, in the long run.

Installation is a simple procedure. See that the rings are installed as lettered to correspond with similar letters on the case. As simple as A-B-C.

ORIGINAL FRANCE METAL PACKING
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Satisfaction Guaranteed

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Original **FRANCE METAL PACKING**

Lucas Medal to John R. Suman

John Robert Suman, vice-president of the Humble Oil and Refining Company of Houston, Texas, has been awarded the Anthony F. Lucas Gold Medal for 1943 by the American Institute of Mining and Metallurgical Engineers for his "distinguished achievement in improving the technique and practice of producing petroleum." The announcement of the award was made by A. B. Parsons, secretary of the Institute.

JOHN R. SUMAN

Although he is still a young man, Dr. Suman might well be designated the "father of petroleum engineering." More than any other single individual he is responsible for the improved efficiency in oil production attained through the adoption of modern engineering and technical methods. The oil-producing research carried on under his direction has revolutionized production methods and has established "oil-reservoir engineering" on a sound foundation. It is conservatively estimated that the improved efficiencies and the greater economies made possible by this research have cut oil producing costs in two and doubled the proportion of recoverable oil.

The Anthony F. Lucas Medal is awarded in recognition of "distinguished achievement in improving the technique and practice of finding or producing petroleum." The award for 1943 was made on the recommendation of a special committee of 16 leaders in the petroleum industry of which J. Terry Duce, director, Foreign Division, Office of Petroleum Coördinator, Washington, D. C., is chairman.

Correction

In Part 1 of the article "Petroleum Development in Canada" by Floyd K. Beach, October issue, under the heading "Northwest Territories" the statement was made that "Geological reports indicate that this oil strike was in shale . . . and would not be expected to yield oil for very long." The author wishes to retract this statement, as he has learned since preparing the article that the early geological reports were now known to be based on a misapprehension, perhaps due to faulty formation samples.

In Part 2 of the article, appearing in the November issue, under the discussion of Turner Valley, the total volume of gas drawn from the gas cap in the Turner Valley field from 1924 to the end of 1941 was given as 1,060,000,000 cu. ft. This should have been 1,060,000,000 M. cu. ft.

Under Turner Valley, the statement was also made that to the end of 1941 wells listed as "oil wells" had produced 33,500,000 bbl., and, in the same paragraph, that some wells in the field had sustained production with a gas-oil ratio of only 666 cu. ft. of gas per bbl. of oil. Both figures were intended by the author to be considered as approximate.

Under "Price of Oil", also in Part 2 of the article, the figure 0.075 percent (deduction for pipe-line loss) should have been 0.75 percent.

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W. H. Knight Appointed by Elastic Stop Nut

Appointment of William H. Knight as director of sales and market research for the Elastic Stop Nut Corporation, has been announced by Thomas H. Corpe, general sales manager of the company. The Elastic Stop Nut Corporation, manufacturers of self-locking nuts, has plants in Union, New Jersey, and Lincoln, Nebraska.

Knight has 20 years' experience in sales and marketing activities. He was formerly vice-president of Electric Household Utilities Corporation, Chicago. Prior to that he was a sales executive for 13 years for the Firestone Tire and Rubber Company, Akron, Ohio.

Dinner in Honor of Vladimir N. Ipatieff

A dinner was given to honor Professor Vladimir N. Ipatieff, on November 20, in Chicago, by the American Institute of Chemists, of which Dr. Gustav Egloff, director of research of Universal Oil Products Company, is president.

Three papers were presented:

"Ipatieff's Influence on Industry", by Dr. Gustav Egloff, president, American Institute of Chemists and Director of Research, Universal Oil Products Company, Chicago.

"Vladimir N. Ipatieff", by Professor Ward V. Evans, Northwestern University.

"My Twelve Years in the U. S. A.", address delivered by V. N. Ipatieff.

The dinner, which was at the Adventurers Club, 14 North Michigan Avenue, was to celebrate the professor's reaching three important milestones in his career at the same time; namely, his fiftieth year in chemistry, his golden wedding anniversary, and his seventy-fifth birthday. The occasion also marked the twelfth year as director of chemical research of Universal Oil Products Company.

LEFT TO RIGHT: J. G. Alther, vice-president, H. J. Halle, president, and Dr. Gustav Egloff, director of research, Universal Oil Products Company; Dr. Frank C. Whitmore, dean, Pennsylvania State College; Dr. Vandeveer Voorhees, Standard Oil Company of Indiana; Professor Ipatieff; Mrs. Ipatieff, and Dr. Ward V. Evans, professor of chemistry, Northwestern University.

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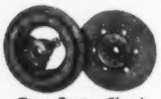

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TRADE LITERATURE

What to Write For

E. D. BULLARD COMPANY, 275 Eighth Street, San Francisco, California, offers "The New Rubber Lung", a circular describing a resuscitation device that stimulates resumption of natural breathing in cases of electric shock, asphyxiation, drowning, and suspended breathing from other causes.

A SPECIAL BULLETIN dealing with Cook's Compressor Rings will be sent on request to interested parties. Ask for Bulletin 372, addressing C. Lee Cook Manufacturing Company, Inc., Louisville, Kentucky.

A NEW BOOKLET, "Threshold to the Future", tells of "a newer and better Cummins Diesel engine that is now building . . . one which will do your job at a lower cost, for a longer time, with fewer replacements and service requirements". A copy will be sent upon request to Cummins Engine Company, Columbus, Indiana, or to the Mid-Continent Supply Company, Fort Worth, Texas, distributors for Cummins engines in the Mid-Continent area.

COMPLETE DETAILS on the protection given pipe lines by application of NO-OX-ID and NO-OX-IDized wrapper can be obtained by addressing Dearborn Chemical Company, Dept. L, 310 South Michigan Avenue, Chicago, Illinois.

"101 SUGGESTED GOOD OPERATING PRACTICES" gives information on friction materials, among which is brake lining, and on more efficient use of packings, insulations, roofings, and refractory cements. A copy may be had by writing Johns-Manville, 22 East 40th Street, New York, New York.

MACWHYTE COMPANY, 2940 Fourteenth Avenue, Kenosha, Wisconsin, has reprints available of a number of informative articles on wire rope conservation. In an advertisement elsewhere in this issue the bulletins are listed and a coupon provided for obtaining them, any or all of which are free.

MID-CONTINENT PUMP SUPPLY COMPANY, Tulsa, Oklahoma, subsidiary of Pacific Pump Works, Huntington Park, California, has issued a bulletin describing its regrinding and service procedure for Pacific Deep Well Plunger Pumps.

TUBE-TURN CATALOG AND DATA BOOK NO. 111 contains essential engineering information for designers of welded piping systems and buyers of welding fiittings, plus new technical studies and practical aids. It is obtainable from Tube Turns, Inc., 137 East Broadway, Louisville, Kentucky.

A BULLETIN that describes and pictures the line of steel derricks and substructures manufactured by Emsco Derrick and Equipment Company, 6701-7101 South Alameda Street, Los Angeles, has just been issued. This publication, Bulletin No. 150-E, can be had free upon request.

WHEELCO INSTRUMENTS COMPANY, Harrison and Peoria Streets, Chicago, Illinois, has issued Bulletin Z-6100, of 16 pages, giving a condensed listing of the company's complete line of measuring and control instruments. Unit construction of temperature controllers is described and illustrated, as is the company's "electronic principle" for obtaining control without contact between measuring and control functions of the instrument. Also covered are remote controllers, combustion safeguard equipment, and other instruments.

"First Aid for Faithful Chain Drives" is the subject of a new factual Folder No. 1951 printed by Link-Belt Company, 307 North Michigan Avenue, Chicago, Illinois.

It tells what can be done to keep chain drives running, when repairs or replacements are unavailable. It covers what to do for worn chain and for worn wheels, and shows how to get new life from old chain pins. Seven servicing suggestions are given that will make any chain drive run better and last longer.

Folder No. 1951 is timely and worth sending for. Address nearest Link-Belt office.

"Wartime Maintenance Digest" describes how new, time-saving cleaning materials, de-scaling methods, and related techniques are being successfully used throughout the petroleum industry to shorten equipment down-time, conserve man-power, and step-up efficiency in handling 41 vitally important, commonly recurring equipment maintenance, plant housekeeping, and sanitation jobs. On each cleaning or related job discussed, this wartime maintenance guide outlines in data sheet form for convenient, quick reference (1) the material used, (2) method followed, (3) time saved, (4) fire or other hazards eliminated, and (5) other advantages gained essential to increasing operating efficiency as well as obtaining greater output and longer service from Diesel and gas engines, coolers, condensers, compressors, and other refinery and pumping station equipment. Copies available on request from Oakite Products, Inc., 48 Thames Street, New York, New York.

New Officers San Joaquin Valley Chapter A.P.I.

The regular meeting of the San Joaquin Valley chapter of the American Petroleum Institute was held at the Standard 11-C Meeting Hall, Taft, California, November 17.

As a result of an amendment to the by-laws, regular meetings in the future shall be held at 7:30 p. m. on the third Tuesdays of January, March, May, September, and November.

The following new officers were elected: George O. Suman, chairman, Tide Water Associated Oil Company; C. H. Montgomery, first vice-chairman, Continental Oil Company, and Fred E. Smith, second vice-chairman, The Ohio Company.

The Advisory Committee, terms expiring in 1944, is as follows: K. E. Grigsby, The Norwalk Company; Don E. Koch, The Superior Oil Company; J. C. Rector, Union Oil Company; R. E. Sallady, C. C. M. O. Company; A. L. Tietze, Standard Oil Company; W. J. Shultz, Crescent Petroleum Company; A. C. Wright, Shell Oil Company, Inc.; W. T. Woodward, State Division of Oil and Gas, and H. V. Dodd, State Division of Oil and Gas.

Oil Center Tool Elects Officers

At a meeting of the board of directors of Oil Center Tool Company, Houston, Texas, on December 7, the following officers of the company were re-elected: A. J. Penick, president and general manager; H. D. Start, vice-president, and B. V. Fisher, secretary-treasurer and assistant general manager. The titles of general manager and assistant general manager were added to the previous titles of Penick and Fisher, respectively.

P. B. Wright, Jr., Promoted by Lone Star Cement

Purd B. Wright, Jr., has been appointed manager of the Incor Division and advertising manager of the Lone Star Cement Corporation, New York, New York, to succeed Dewey Thompson. He will make his headquarters in New York.

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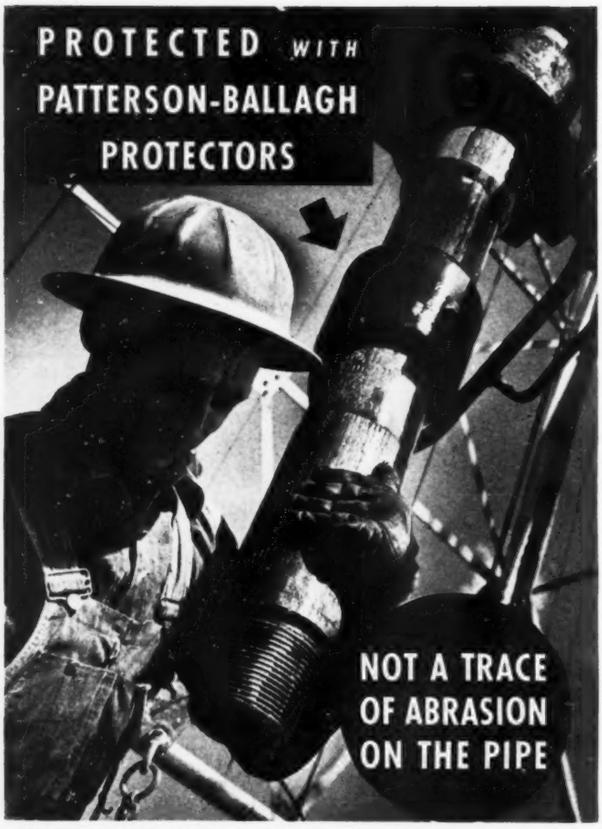

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Book Reviews

Motor Truck Facts, 1942 Edition. Published by Motor Truck Committee, Automobile Manufacturers Association, 830 Transportation Building, Washington, D. C. 56 pp.; gratis.

The impact of the war on motor trucking is made strikingly clear in this 1942 edition of the annual volume of facts about the industry. Comparisons with World War I, when only 326,000 trucks were in use (4,911,000 now), contributions of the truck in the transportation, registrations, sales, value, fleet ownership, etc., are presented. New are preliminary data from the Public Roads Administration studies of highway use, showing mileage and other data by trucks. Truck taxes, state size and weight limits, and government limitation and ODT orders, also are given.

●

The National Paint Dictionary (Second Edition), by Jeffrey R. Stewart. Published by Stewart Research Laboratory, 1340 New York Avenue, N. W., Washington, D. C. Price: $7.50.

The author, who is a consulting and analytical chemist and editor and publisher of *National Paint Bulletin,* has prepared a handy reference volume for chemists, production managers, purchasing agents, formulators, technologists, salesmen, advanced painting contractors, distributors, and all those engaged either directly or indirectly in the manufacture, distribution, consumption, or application of paint and allied products. This volume contains definitions of the terms used, together with pertinent information regarding the names of chemicals, raw materials, methods of analysis, equipment, and apparatus employed in the paint and allied industries.

Heads A.P.I. Committee

RALPH W. MARSHALL

Ralph W. Marshall, vice-president and manager of California operations for Drilling and Exploration Company of Los Angeles, California, is the new national chairman of the Topical Committee on Drilling Practice of the American Petroleum Institute. Marshall has been associated with the drilling of oil wells and the study of drilling problems for many years. During the last year he was chairman of the Cailfornia District Topical Committee on Drilling Practice.

Pattin Brothers Sold

Acme Fishing Tool Company, Parkersburg, West Virginia, announces through its president, L. M. Ludlow, the purchase of Pattin Brothers, Inc., manufacturing firm of Marietta, Ohio. The latter manufactures pumping powers, compressors, gas pumps, steel tanks, oil well and mill supplies, iron and brass castings, and handles repair and welding jobs.

W. F. Meister, president and general manager of Pattin Brothers, Inc., will continue as manager of the Marietta plant.

MEETINGS

California Natural Gasoline Association, Monthly Meeting—January 7, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers, Annual Meeting—February 15, 16, 17, and 18, 1943, New York, New York.

American Association of Petroleum Geologists, Annual Meeting—April 7, 8, and 9, Fort Worth, Texas.

American Petroleum Institute, Division of Production, Eastern District—April 8 and 9, 1943, William Penn Hotel, Pittsburgh, Pennsylvania.

Petroleum Industry Electrical Association, Annual Meeting—May 5 and 6, Houston, Texas.

W. S. Farish, President Standard Oil, Dies

W. S. Farish, president of the Standard Oil Company (New Jersey), died unexpectedly November 29 of a heart attack at Millbrook, New York, where he was visiting friends. He was 61.

W. S. FARISH

Farish was a pioneer in developing the first important oil pool in Texas. He was an organizer and leader of the National Petroleum War Service Committee that handled all oil supplies for the Allies in the first World War and was an organizer and later president of the American Petroleum Institute.

Farish was born in Mayersville, Mississippi, on February 23, 1881, and helped finance his way through college as a school teacher. Graduated from the University of Mississippi with a law degree in 1900, he practiced law for three months in Clarksdale, Mississippi.

When oil was discovered in Beaumont, Texas, in 1901, Farish went to the boom town, where he later founded the Brown-Farish Oil Company.

He was a founder in 1917 of the Humble Oil and Refining Company, serving as its vice-president. The Standard Oil Company of New Jersey bought a substantial stock interest in Humble and Farish became chairman of the board of the former in 1933. In 1937 the directors elected him to become president and chief executive officer of the company, succeeding W. C. Teagle.

Since the outbreak of the present war Farish had spent much of his time in Washington as a member of the Petroleum Industry War Council.

He is survived by his widow, Mrs. Libbie Randon Rice Farish of Houston, Texas, whom he married June 1, 1911, and a son and daughter, Lieut. Williams Stamps Farish, Jr., of the United States army air corps, and Mrs. Martha Botts Gerry.

Brief services were held in St. James church in New York City, with members of the Standard Oil Company board of directors serving as honorary pallbearers. Funeral services were held at his home in Houston and burial was in Glenwood Cemetery there.

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